Handbook of Research on Effective Electronic Gaming in Education

Richard E. Ferdig
University of Florida, USA

Volume I

INFORMATION SCIENCE REFERENCE
Hershey · New York

Director of Editorial Content: Kristin Klinger
Managing Development Editor: Kristin M. Roth
Senior Managing Editor: Jennifer Neidig
Managing Editor: Jamie Snavely
Assistant Managing Editor: Carole Coulson
Copy Editor: Maria Boyer, Amanda Appicello
Typesetter: Carole Coulson
Cover Design: Lisa Tosheff
Printed at: Yurchak Printing Inc.

Published in the United States of America by
Information Science Reference (an imprint of IGI Global)
701 E. Chocolate Avenue, Suite 200
Hershey PA 17033
Tel: 717-533-8845
Fax: 717-533-8661
E-mail: cust@igi-global.com
Web site: http://www.igi-global.com

and in the United Kingdom by
Information Science Reference (an imprint of IGI Global)
3 Henrietta Street
Covent Garden
London WC2E 8LU
Tel: 44 20 7240 0856
Fax: 44 20 7379 0609
Web site: http://www.eurospanbookstore.com

Handbook of research on effective electronic gaming in education / Richard E. Ferdig, editor.
p. cm.
Summary: "This book presents a framework for understanding games for educational purposes while providing a broader sense of current related research. This creative and advanced title is a must-have for those interested in expanding their knowledge of this exciting field of electronic gaming"--Provided by publisher.
Includes bibliographical references.
ISBN 978-1-59904-808-6 (hardcover) -- ISBN 978-1-59904-811-6 (e-book)
1. Simulation games in education--Handbooks, manuals, etc. 2. Electronic games--Handbooks, manuals, etc. I. Ferdig, Richard E. (Richard Eugene)
LB1029.S53H36 2008
371.39'7--dc22
2007052787

British Cataloguing in Publication Data
A Cataloguing in Publication record for this book is available from the British Library.

Chapter XIX
Pre-Service Computer Teachers as 3D Educational Game Designers

Zahide Yildirim
Middle East Technical University, Turkey

Eylem Kilic
Middle East Technical University, Turkey

ABSTRACT

This chapter explores prospective computer teachers' perceptions of and experiences in goal-based scenario (GBS) centered 3D educational game development process. Twenty-six pre-service computer teachers who enrolled in a Design, Development and Evaluation of Educational Software undergraduate course formed the sample of this case study, and they, in groups, developed GBS-centered 3D educational games. The data were collected through GBS evaluation checklists, interviews, and formative evaluations. The findings indicated that the pre-service teachers preferred GBS-centered educational games to traditional educational games. They declared that the most important feature of educational games was their contribution to motivation, attention, and retention. Although the majority of the groups developed their educational games in line with GBS, they had difficulty creating a realistic scenario and mission. Unlike what the literature indicates, one of the group's formative evaluation results showed that while the second graders prefer realism, the sixth graders prefer more fantasy in the scenario.

INTRODUCTION

Digital game-based learning has been used extensively in a wide variety of businesses like consulting firms, manufacturing companies, and military institutions. Even though there are successful examples, there is still doubt in the effectiveness of digital game-based learning. There are two main arguments about digital game-based learning that are not yet accepted fully in the adult learning community. The first argument is that the learners have changed deeply and grew up digital. The second one is that individuals are experienced in the new form of play, computer and video games, and theses experiences shape their preferences and abilities for their learning (Prensky, 2001).

One of the most important issues in designing digital game-based learning is to facilitate reflection and critical thinking while learning, and still create enjoyable games (Prensky, 2001). In designing educational games, a careful application of the story and the character is essential. According to Falstein (2005), game-play and story shape each other, and integrating storyline into game can help a player control his or her character in the game. In games, it is essential to allow the player to make progress in the storyline *by doing activities,* rather than by simply watching the cut scenes. A goal-based scenario (GBS) in this respect is a promising approach in designing educational games to facilitate reflection and critical thinking, and to integrate storyline into games. A GBS with a cover story, mission, the roles given to the learners, and goals in the scenario can provide an appropriate theoretical framework in designing effective educational games.

In a GBS, the students try to find solutions to problems in the domain of students' goals, and learning occurs while students are achieving those goals in a certain context (Schank, Fano, Bett, & Jona, 1994; Schank, Berman, & Macpherson, 1999). Rather than representing the topic to the student, GBSs are developed based on the skills that a student can learn. The value of a GBS approach is clear at this point since a GBS emphasizes creating a model in which learning goals aim for the learner to learn "how to" rather than "know that" (Schank et al., 1999). Defining skills as "knowing how to do something" is the essence of the GBS. The underlying principles of a GBS are founded on Case-Based Reasoning (CBR) theory. It is the theory of memory and learning which aims to explain how people remember and use their memories in order to solve new problems (Schank et al., 1994, 1999). It focuses on solving new problems by using or adapting the solutions of the old problems (Riesbeck & Schank, 1989). Most of the time, individuals can transfer past experiences into the new one; this transfer is critical in the use of CBR efficiently.

The effective learning environment creates conditions that produce strong intrinsic motivation to learn (Schank et al., 1994). A GBS itself comprises a rich context and provides interesting and complex activities that increase students' intrinsic motivation (Schank et al., 1999). GBSs can be applicable to all levels for both formal and informal learning situations. They provide learners with active involvement in the learning environment, which represents the facts and skills in the context of real-world use.

Several researchers examined the users' opinions of GBS-centered educational learning environments through field studies. For example, Bell, Bareiss, and Beckwith (1993) developed a program called "Sickle Cell Counselor." The evaluation results indicated that the users spent a lot of time using the program. This result was important because the program was presented in a museum, and the visitors were not required to use it. They concluded that the program was interesting for the users. In addition, they found that the program's users made fewer irrelevant responses on the post-test than the pamphlet users did. The most important result of the evaluation was that the "Sickle Cell Counselor" group learned the conditions of applicability of the new knowledge. In another study, Zumbach and Reimann (2002) compared different methods—a GBS, and tutorial and strategy training by using hypertext. Comparison of the three approaches showed that the GBS was more motivating, learners acquired better overviews, and they were able to use their knowledge in the argumentation task. While the GBS was better for structural knowledge, it did not give better results for factual knowledge. Another finding of the study was that the GBS provided intrinsic motivation. Schaller, Bunnell, and Nagel (2001) indicate that a GBS provides extrinsic motivation for uninterested but potential learners, especially when a program's appeal is increased by narratives, games, simulations, and creative play activities. Schoenfeld-Tacher, Persichitte, and Jones (2001a) investigated the impact of a GBS on different learners. In their study, they found out that the GBS provided equal opportunities for the learners from different gender and ethnicity. Additionally, the researchers indicated that such a learning environment was more beneficial for the students who possessed formal reasoning ability that was necessary to examine and to develop hypotheses in scientific settings. Foster and Bareiss (1995) state that this type of instruction eliminates some of the deficiencies in traditional methods, and makes learning more motivating for the students. Foster (1994), and Naidu, Ip, and Linser (2000) mention that the traditional case method has some shortcomings such as logistics and unwillingness, and the GBS has the ability to eliminate these shortcomings.

The research results indicate that the GBS has a positive effect not only on the teaching and learning process but also on students' motivation, and it is appropriate for teaching complex learning skill. Many studies emphasize that a GBS is an effective way of teaching by providing opportunities for learners to understand why and how they use the knowledge (Bell et al., 1993; Schoenfeld-Tacher et al., 2001a, 2001b; Zumbach & Reimann, 2002). Developing computer-based GBSs may increase the opportunities to benefit from the GBS approach, because of the capability of the computer to meet the needs of prerequisite conditions for the appropriate use of the GBS (Schank et al., 1994). The GBS architecture requires authoring tools for education and training, contains a theory of learning within them, and ensures that the application is in line with the principles of that theory (Schank, Korcuska, & Jona, 1995). Therefore, developing an effective GBS for computer-based learning environments requires software produced based on the theoretical framework of GBSs, and evaluation of its effectiveness.

Schank et al. (1999) state that "there is only one effective way to teach someone how to do something and that is to 'let them do it,'" and they described the GBS as "a learning-by-doing simulation in which students pursue a goal by practicing target skills and using relevant content knowledge to help them achieve their goal" (p. 165). Since learning how to design and develop instructional software requires a contextual learning environment, it is appropriate to provide an authentic learning environment to prospective computer teachers who are taking the Design, Development and Evaluation of Educational Software (DDEES) course. An authentic learning environment would help them implement the theoretical bases of the course content to GBS-centered three-dimensional educational games they had to develop.

Therefore, the purpose of this study is to provide a contextual learning environment to pre-service computer teachers, and investigate their experiences in and perceptions of a GBS-centered 3D educational game development process. More specifically, this study attempts to answer the following research questions:

1. To what extent do the pre-service computer teachers' GBS-centered 3D educational games reflect the components of the GBS?

2. What are the pre-service computer teachers' perceptions of GBS-centered 3D educational games?
3. What are the findings of formative evaluation of GBS-centered 3D educational games developed by the pre-service computer teachers?

METHOD

To investigate pre-service computer teachers' experiences in and perceptions of a GBS-centered 3D educational game development process, a case study design was used in this study. For this purpose, a specific undergraduate course, DDEES, was selected, and the students who enrolled in the course formed the sample of this study. Interview techniques, GBS evaluation checklists, and formative evaluations were used to collect the relevant data. Below, the detailed description of the subjects, the study, the procedures, and the data collection and analysis procedures are presented.

Subjects of the Study

This study included 26 fourth-year Computer Education and Instructional Technology students taking the DDEES course at Middle East Technical University in Turkey. The course consists of three credits (two theoretical hours and two practice-lab hours). The fourth-year students in one of the two sections of the course formed the sample of this study. Twenty-nine pre-service computer teachers enrolled in the section, but 26 subjects (19 males and 7 females) participated in the study. One of the groups consisting of three students did not participate in all phases of the course, and therefore they were excluded from the study. The majority of the students graduated from computer departments of technical or vocational high schools, and by their fourth year in the department, they had gained the necessary technical skills and knowledge (such as programming and instructional design) to develop educational software. They are knowledgeable about computer games and computer-based educational games. However, they did not have the necessary skills in 3D design. Therefore, in the beginning of the study, they received some training related to 3D design. The DDEES course is given in the last semester of the program, and in the course, prospective computer teachers were expected to implement what they learned up to the last semester in their educational software projects. After graduating, they are expected to work as computer teachers at K-12 schools, or they work as instructional designers in the educational software development field.

Procedures

In the beginning of the semester (14 weeks), the students were informed that as a DDEES course project they were supposed to develop a GBS-centered 3D educational game in groups. The students were requested to form their own project groups (seven of them) that included two to four students each.

The DDEES course was divided into two parts. During the first part (the first seven weeks), theoretical bases of software development process were provided. During the second part (the remaining seven weeks), the prospective computer teachers developed their GBS-centered 3D educational games. The first seven weeks of the theoretical hours of the course, the students were provided theoretical bases of an educational software development process on principles of learning; general attributes of educational software, games, simulations, and the GBS approach; and ADDIE and Rapid Prototyping instructional design models. During the practice hours of the first part, the students played with three educational games and wrote reflective journals individually about the games. In their journals, they compared three games on their educational aspects. For the remaining time, they examined the features of Blaxxun Studio, the 3D environment development software. They also received a six hours of training on 3D design.

In the second part of the course, the students worked on their GBS-centered 3D educational game projects. To be able to achieve the DDEES course goals, students went through design, development, and evaluation processes of effective educational software. They followed the Rapid Prototyping Model (Tripp & Bichelmeyer, 1990) in the development process. The students in groups developed their educational software considering the seven components, the learning goals, the mission, the cover story, the role, the scenario operations, the resources, and the feedback of the GBS. During this period, a consultation schedule was prepared and each group consulted the instructor on their projects and project reports on a weekly basis. They received weekly feedback on what they have done from the instructors during the consultation periods. In order to guide students in this process, the students were provided with analysis, design, development, and evaluation templates. While they produce the documentation part of their projects, at the same time they developed paper-based and computer-based prototypes of GBS-centered 3D educational games, and conducted formative evaluation. Based on the feedback gathered from the instructors and the formative evaluation results, they made revisions on their prototypes. This iterative procedure lasted until the final versions of the GBS-centered 3D educational games were created. At end of the semester, the groups finished their GBS-centered 3D educational game, and presented their experiences and projects to their classmates.

Data Collection and Analysis

In order to evaluate the GBS-centered 3D educational games developed by students, a GBS evaluation checklist developed by Nemoto and Suzuki (2005) was modified based on the components (the learning goals, the mission, the cover story, the role, the scenario operations, the resources, and the feedback) of the GBS. The evaluation checklist consisted of 22 Likert-type criteria (three for scenario, two for goals, four for mission, two for cover story, two for roles, four for instructional strategies and activities, four for resources, and one for feedback) where 5 indicates ‘definitely appropriate’ and 1 indicates ‘definitely not appropriate’. The students’ projects were evaluated by the two researchers to assess if the students developed their 3D educational games in line with the GBS approach.

To investigate pre-service computer teachers’ opinions of their GBS-centered 3D educational games and game development processes, semi-structured interviews were conducted with the project groups. The interview schedule consisted of three main questions comparing the GBS-centered 3D educational game approach with a traditional educational game approach, with the sub-questions in regard to learning, motivation, retention of knowledge, transfer of knowledge, assessment of learning outcomes, and the difficulties they faced while implementing the components of a GBS into their project. At the end of the semester, 26 students who were included in the study were interviewed in their project groups. Hence, seven group interviews were carried out.

The first reason for preferring group interviews to individual interviews was that from the beginning of the semester, pre-service computer teachers worked in their project groups and experienced the GBS-centered 3D educational game development process together. The second reason was that in group interviews, the interviewees consider what others in the group say and then may build upon those shared opinions. Each group member might bring a different perspective on the issue interviewed (Patton, 1987). Before each interview was performed, the students were informed of the purpose of the interview, and all of the interviews were tape-recorded with the permission of the pre-service computer teachers.

Additionally, the data gathered from the formative evaluation were examined to understand the target students' (game players) opinions of GBS-centered 3D educational games.

The data gathered through the GBS checklist were analyzed by descriptive statistics. Descriptive analyses of the items in the scale in terms of means were carried out, and then the sub-scale scores were calculated for each component of the GBS. The data gathered from the evaluation checklist were interpreted under the components of the GBS. The interview data were subjected to content analysis. As Miles and Huberman (1994) have stated, meaningful phenomena in the data is searched and descriptive codes are assigned in content analysis. Marshall and Rossman (1999) indicated that data analysis includes ordering, structuring, and interpreting the mass of collected data. Through the content analysis, main themes were withdrawn from the interview data, and then the data were interpreted under these themes. Lastly, formative evaluation results of GBS-centered 3D educational games were interpreted under the related themes. In order to attain interpretative validity, the original interview and formative evaluation data and all the interpretations were reviewed, and the conclusions drawn from this process were verified by the two researchers of the study.

RESULTS

Descriptive Results

GBS-centered 3D educational games developed by pre-service computer teachers were assessed based on the GBS evaluation checklist. As Table 1 shows, the majority of the groups developed their 3D educational game based on GBS design principles. While one of the groups' GBS checklist mean score (M=3.27) was at average level, for the remaining six groups, it was above average (from M=3.77 to M=4.09). However, it was not possible to state that all groups considered all components of GBS in their design.

As Table 2 presents, four groups out of seven developed their *scenario* in line with the checklist (M=4 to M=4.33). Group 7's scenario was below average (M=2.67), and Group 3's and Group 6's scenarios were in the average range (M=3.33). When the results gathered from the checklist were examined based on the sub-items in the scenario theme, five groups out of seven performed poorly (M=2), and only two groups performed above average (M=4) related with the item "the scenario is somewhat realistic."

While one of the groups performed at average level (M=3.25), the remaining six groups developed their missions in line with the checklist (M=3.50 to M=5). When the results gathered from the checklist were examined based on the sub-items in the mission theme, similar results to the scenario theme were observed. Five groups out of seven performed poorly (M=2), and only two groups performed very well (M=5) in relation to the item "the mission is somewhat realistic."

The groups performed well on cover story theme. The mean scores of the groups' performance varied from M=4 to M=5. About the roles given to the players in the scenario, all groups performed above average (M=3.50 to M=4), showing that the roles given to the players in the scenarios were somewhat motivating, and providing practice for the necessary skills (see Table 2).

Table 1. Overall performance of groups on GBS components

	Grp.1	Grp.2	Grp.3	Grp.4	Grp.5	Grp.6	Grp.7

Table 2. Evaluation results of 3D educational game based on GBS components

	Scenario	Goals	Mission	Cover Story	Roles	Strategies/ Activities	Resources
Group 1	4	4	3.75	5	4	4.25	3
Group 2	4.33	4	5	4.50	4	4	3
Group 3	3.33	4	3.5	4	4	4.5	3.75
Group 4	4	4	3.75	4	4	4	3
Group 5	4	4	4.75	5	4	4.25	2
Group 6	3.33	3.50	3.50	4	4	3.50	4
Group 7	2.67	3.50	3.25	4	3.50	3.25	3

Instructional activities and strategies the students employed in the GBSs are above average (M=3.50 to M=4.25) except for one group (M=3.25), indicating that six groups out of seven used appropriate instructional activities and strategies in their GBSs.

The lowest scores the projects received were related to "resources." Only two groups performed above average, four groups performed at average (M=3), and one group performed below average (M=2). This result shows that the students focused on other GBS components and 3D design, but did not give enough importance to the resources.

Interview Results

Motivation and Attention

All students (N=26) in seven groups, based on their experiences and the formative evaluation of their projects, indicated that they preferred GBS-centered 3D educational games to traditional educational games. The most important feature of GBS-centered educational games perceived by the students was *motivation and attention.* They were in the opinion that the GBS was efficient for learning since the students were drawn to it.

One student from Group 2 indicated that the "student's attention is drawn into learning through various aspects of GBS such as mission to fulfill." Another student from the same group stated that "when the instructor presents the subject, I can listen to him/her about five minutes. Then, I lose my motivation and attention. There is not much to draw my interest, so I do not learn only in class, but I have to study from the notes. In GBS, there is a goal to achieve, and the student should reach that goal alone, for that reason s/he learns. If GBS is prepared good enough, the student can reach the goal without any problem."

Related to motivation, another student from the same group declared, "There is a big difference between GBS-centered 3D educational game and traditional educational game. In the latter one, the goal is to learn, but in GBS, there is another goal (mission) except learning goal. While fulfilling the mission, the student learns. This makes big difference in terms of motivation in favor of GBS." Another student from the same group stated, "The student sees the results of his/her actions immediately. This increases motivation, at the same time increases desire to learn." Students from Group 1 had similar statements. One student mentioned, "In GBS, the student is not given the information, s/he tries to achieve something (mission) and this motivates the students." The members of Group 4 have similar ideas related to GBS. One student from this group indicated, "Rather than giving knowledge directly, it results in better learning and high motivation when students are involved actively through scenario." One student from Group 5 made similar comments, "Motivation is one of the problems the teachers face very often. If the students are bored in direct instruction, it can be solved by GBS, because the students have goals to achieve, the student is not the receiver and s/he is expected to achieve something, this helps the student learn easily." Students' statements from Group 6 were also in favor of a GBS. Members of the group indicated that a "good scenario is more effective than the other methods, and it helps learners focus on the goal." However, one student declared that "in both traditional and GBS approaches, it depends on the student. If the student is not interested in the course/subject, it is difficult to motivate the student."

Retention and Transfer

Another theme drawn from the interviews was *retention and transfer*. The majority of the students were of the opinion that learning by doing would result in retention of knowledge and transfer of learning. One of the students from Group 5 indicated, "In GBS, we help and provide guidance to the students but we do not provide exact information. The students find the exact information or answer by himself/herself. For that reason, it is more effective and knowledge retained better." One student from Group 8 mentioned, "In GBS, the learner is learning by doing, the learner is actively involved in the process, so the learning is better." One student from Group 2 mentioned, "Realistic practice in GBS would result in transfer of learning into other areas." Similarly, another student from the same group indicated, "If the goal in GBS is realistic, it is easier to integrate with real life." The members of Group 5 stated that transfer of knowledge to real life depends on how effectively the GBS is designed. If it is designed well, the possibility of the transfer is high. Even though both approaches, GBS-centered educational games and traditional educational games, may result in transfer, when they are compared, the GBS would be more effective in terms of transfer. Similarly some students (N=5) stated, "GBS-centered educational games might be more effective to apply [to a] new situation when it is compared to traditional games." The majority of the students indicated that learning by doing would help retention and transfer of knowledge.

Student Centeredness

Another theme drawn from the interviews was *student centeredness* of GBS-centered educational games. The students found the GBS approach more student centered than other approaches. They mentioned that since students try to fulfill the mission throughout the process in a GBS, they are being active rather than passive. One student from Group 5 stated, "In GBS we want the student to do something, and we provide some guidance but we do not give the exact information. The student solves the problem or finds the correct answer by him/herself. Therefore, GBS is more effective than other methods." Another student from the same group stated, "Since the student performs by him/herself in GBS, s/he may gain competence. In GBS, the learner is in the center." One student from Group 4 mentioned, "Rather than giving information directly to the student, it is better to involve students like in GBS. [The] GBS approach is [a] student-centered method, and the learner knows why s/he learns."

Realistic Focus

Even though the groups had the lowest points from the checklist related with the *realistic* scenario in their GBS-centered 3D educational games, they mentioned that the GBS approach is more realistic and related to real life when compared to other approaches. The students indicated that this is one of the positive sides of the GBS approach, and it looks easier to transfer learning outcomes of the

GBS to other situations. One student from Group 2 stated, “If the goal is realistic, the student can integrate it with real life more easily.”

Assessment

The students in six groups were in favor of GBS about *assessment* of learning outcome. They mentioned that if the students fulfill the mission, it is possible that they would learn the subject. The other group also favors a GBS about assessment, but they suggest additional traditional assessment methods. They indicated that multiple assessments could provide more feedback related with students’ learning. Another point students made was that since the students’ performance as examined was based on the actions the student should perform, there is assessment in each step, and so it is easier to detect in which part of the GBS the student is having difficulty. They indicated that rather than evaluating the students at the end of the process, students’ performances would be examined in the process of game-play, so students can be assessed in a long period time.

Problems Faced

When the students were asked about the *problems* they faced while developing their GBS-centered 3D educational game, all of the groups indicated that they had difficulty in deciding on the scenario, feedback, and appropriateness of the mission for the instructional goal. It was also clear from the GBS checklist results that they had difficulty in coming up with a realistic scenario. They mentioned that after deciding on the scenario, it was difficult to integrate the scenario into the game they were to develop. They had concerns about “meaningless and boring scenario,” “possibility of not fulfilling the mission,” and “possibility of inappropriate roles/characters in the scenario and the mission.” Additionally, one group indicated that they had difficulty in deciding on the instructional activities to fulfill the mission.

It can be concluded from the interview results that pre-service computer teachers perceived GBS-centered 3D educational games to be more motivating than educational games designed based on traditional approaches. They thought that students retain and transfer the knowledge they gain from GBS-centered 3D educational games better; they find the GBS more student centered and realistic. While the majority found the GBS approach better for assessment, one group suggested the use of additional assessment methods. In regard to problems faced while developing GBS-based software, they indicated that they all had difficulty in deciding on the scenario, relating mission to instructional goal and providing feedback.

Formative Evaluation Results

Once the fourth-year pre-service computer teachers developed GBS-centered 3D educational games, they were required to test them during their teaching practice at K-12 schools, and to conduct formative evaluation of their games. In this process, they gathered feedback from students, subject area teachers, and computer teachers about their games.

Group 1 conducted formative evaluation with 15 students. The students found the scenario motivating and interesting, and stated that the scenario draws their attention. Students also found the cover story well designed and motivating.

Group 2 performed formative evaluation iteratively. They conducted formative evaluation with nine students; after improving their product, they conducted formative evaluation with seven students and then with two students. The first nine and seven students liked the scenario. They did not criticize the scenario or cover story, but they focused on the dressing and feedback parts of the game like sound, color, texture, and text style. Based on their feedback, the students revised the dressing parts and feedback given in the software. The last two students focused on the difficulty levels of the questions asked in the game; they found the questions difficult for them. Like in other groups, these students also focused on the distracting elements of the game. They found scenario and mission effective. Based on the feedback gathered from the students, the dressing features of the game and difficulty levels of the questions were redesigned.

Group 3 performed their formative evaluation with one expert and eight students. They found that the game did not have challenging factors. However, they liked the overall design of the game. They found the cover story interesting, and the scenario realistic and motivating. They also found feedback and resources effective, and liked the sequence of the questions and points made in the game.

Group 4 conducted formative evaluation with 10 students and one teacher. Both the students and the teacher liked the chains of the events in the game, but they did not like the dressing features.

Group 5 employed iterative formative evaluation with subject matter teacher, computer teacher, and students. In the first evaluation, the students liked the scenario overall. However, the teachers found the roles in the scenario unclear to some degree. In the second evaluation after revision, the teachers appraised the game more positively. They stated that the dialogs of the characters in the scenario were informative to learn the subject, but again feedback provided in the program was insufficient. They also suggested that more difficulty levels to reach the different learners and more motivating elements were needed. They found interface and design well organized. The students liked the game overall. They suggested more mysterious roles and scenario, and required more action, dialogs, and adventure in the program. This result was interesting, because this group's scenario was the most realistic one of all. Rather than having a realistic scenario, as is suggested in the GBS, they required mysterious and fantastic scenarios.

Group 6 conducted iterative evaluation. They gathered information from 15 students first, and then from 20 students, and last from three students and one teacher. Overall, the students liked the game. They found the scenario interesting, mysterious, and fantastic, and liked the flow of the scenario. The best part of the game was found to be the role given to the students in the scenario. The students found the quality and usability of the game satisfactory. However, they indicated that there was a need for more challenging questions in the program. The teacher found the game satisfactory and in line with the subject area.

Group 7 performed the formative evaluation with only one student. Overall, this student found the software well designed and motivating, and the scenario effective.

DISCUSSION

All pre-service computer teachers in seven groups indicated that they prefer educational games developed in accordance with a GBS to traditional educational games. Pre-service computer teachers emphasized that the GBS could motivate students and keep their attention throughout the game-play. Schank et al. (1999) also state that as long as GBS-centered software environments include a rich amount of context and provide interesting and complex activities, they are inherently motivating the students. In such a situation, students are drawn into GBS-centered software. This idea is also supported by the flow theory (Csikszentmihalyi, 1990), which indicates that optimal experiences occur when challenges and skills are high in the context. Based on pre-service computer teachers' experiences in the game development process, it is possible to state that GBS-centered 3D games that include clear and realistic goals, immediate feedback, student-centered activities, and a challenging mission fulfill the condition for the flow.

It is important to get the intrinsic motivation to drive learning in any curricula (Schank, 1993/1994; Zumbach & Reimann, 2002). Especially when adults begin to learn something, they want to know why they should do so. Therefore, the goal must be realistic for adult users. However, the findings of this study raised some points to be investigated. A realistic goal is not the case for every user, such that the goal should also be exciting for the children. The findings of one group's formative evaluation showed that sixth grade students liked a more mysterious GBS; on the other hand, second grade students liked a more realistic scenario. This result could be due to the games in the market because they are mostly mysterious ones and have too much fantasy in them. Therefore, the older students may want to be involved in a mysterious scenario because of their experience with the games in the market. Still, this issue needs to be investigated further to find out what the students at different grade levels think about fantasy and realism in the scenario, and what the levels of learning outcomes of the games that have realism or fantasy in their scenario are.

Prensky (2001) indicates one of the most important issues in designing a game-like learning environment is to facilitate reflection and critical thinking in the learning process and still make the game enjoyable. The findings of this study showed that pre-service computer teachers created GBS-centered 3D educational games that are valuable for learning, and they benefited from this process as game designers.

One of the most important findings of this study is that this study provided a contextual experience to pre-service computer teachers to gain competency in the GBS-centered 3D educational game development process. As indicated by Kafai (2006):

In the case of instructional games, a great deal of thought is spent by educational designers on content matters, graphical representations, and instructional venues. The greatest learning benefit remains reserved for those engaged in the design process, the game designers, and not those at the receiving end, the game players. (p. 39)

In this process, the pre-service computer teachers became the designers of an educational game, and ultimately learned the process of educational game development.

When the students were asked about the problems they faced while developing their GBS-centered 3D educational game, all of the groups indicated that they had difficulty in deciding on the scenario, feedback, and appropriateness of the mission for the instructional goal. It was also clear from the GBS checklist results that they had difficulty in coming up with a realistic scenario. They mentioned that after deciding on a scenario, it was also difficult to integrate that scenario to the game they were to develop. They had concerns about meaningless and boredom, and the possibilities of not fulfilling the mission, and of inappropriate roles/characters in the scenario and the mission. Additionally, one group indicated that they had difficulty deciding on the instructional activities to fulfill the mission.

IMPLICATIONS

Kafai (2006) indicated that in the educational game development process, great effort is spent by the designers of the game on the flow, content matters, visual representations, and instructional activities of the game. As the consequence of this effort, the learning benefit for the designers is greater than that for the end users—the game players. The findings of this study indicated that prospective computer teachers as game designers implemented the principles of a GBS into their games and benefited from the constructionist approach. Implementation of the DDEES course in a constructionist way helped prospective computer teachers design an effective educational game and be critical on the educational value of the games.

After graduating from the program, the majority of the participants in this study either become computer teachers at K-12 schools or work as instructional designers in the educational software development field. When they work as computer teachers at K-12 levels, they play an important role in technology integration into education. In that process, these pre-service computer teachers may select the most appropriate educational games or software for the courses, and in this selection process they might be more critical in regard to values of educational games. If they prefer to work as instructional designers, the experience they gained from the game development process may help them come up with contextual design to facilitate better learning, and become knowledgeable on the critical characteristics of educational games. Kafai (2006) stated that "game-making activities offer an entry point for young gamers into the digital culture not just as consumers but also as producers" (p. 39). As she stated, these prospective computer teachers may become educational game designers of the future.

Even though the new generation is active game players, the field of education lacks the studies done on the values, promises, and challenges of games. Prospective computer teachers in this study experienced the promises and challenges of a GBS-centered 3D educational game throughout the development process, and probably would carry the experiences gained from this process to either K-12 schools or the educational software development field.

In order to help practitioners and policymakers recognize the value and potential of games in education, research studies on the effectiveness of different types of games can be conducted. Additionally, based on these research studies, a new "educational games" course that includes different game design approaches can be designed and developed for the curriculum of instructional technology departments.

Another implication of this study is to conduct new research studies to investigate how different types of game players prefer the realism in GBS-centered games. This can be investigated in relation to different age groups and different subject areas.

The implication of this study for practice in the DDEES course indicated that prospective computer teachers should be provided with effective guidance in determining a realistic scenario, providing resources, and giving importance to instructional activities in a GBS-centered 3D educational game. In order to help prospective computer teachers see the immediate effect of their design, the formative evaluation process should be made easier for prospective computer teachers to implement.

As a conclusion remark, this study is limited to the case investigated in this study and the participants enrolled in the DDEES course. Therefore, the findings of this study cannot be generalized directly to similar groups, and further research studies are needed to support these findings. Despite these limitations, this study provides a valuable contribution into our understanding of educational games designed and developed based on a GBS approach in a pre-service teacher education course.

REFERENCES

Bell, B., Bareiss, R., & Beckwith, R. (1993). Sickle Cell Counselor: A prototype goal based scenario for instruction in a museum environment. *Journal of the Learning Sciences, 3,* 347-386.

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

Falstein, N. (2005). Understanding fun—a theory of natural fun activity. *In* S. Rabin (Ed.), *Introduc-*

tion to game development (pp. 71-98). Boston: Charles River Media.

Foster, D.A. (1994). Using a goal-based scenario to teach financial statement analysis. *ACM SIGCUE 0utlook, 22*(2), 23-31.

Foster, D.A., & Bareiss, R. (1995). Administering the business school case method with a goal-based scenario. *Proceedings of the Annual Meeting of the American Educational Research Association,* San Francisco, CA.

Kafai, Y.B. (2006). Playing and making games for learning: Instructionist and constructionist perspectives for game studies. *Games and Culture, 1*(1), 36-40.

Kass, A., Burke, R., Blevis, A., & Williamson, M. (1994). Constructing learning environments for complex social skills. *Journal of the Learning Sciences, 3*(4), 258-264.

Marshall, C., & Rossman, G.B. (1999). *Designing qualitative research* (3rd ed.). Thousand Oaks, CA: Sage.

Miles, B.M., & Huberman, A.M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: Sage.

Naidu, S., Ip, A., & Linser, R. (2000). Dynamic goal-based role-play simulation on the Web: A case study. *Journal of Educational Technology & Society, 3*(3), 190-202.

Nemoto, J., & Suzuki, K. (2005). *GBS checklist for training application.* Retrieved January 14, 2005, from *http://www2.et.soft.iwate-pu.ac.jp/~nemoto/paper/jsise0405.pdf*

Patton, M.Q. (1987). *How to use qualitative methods in evaluation.* Beverly Hills, CA: Sage.

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

Schaller, D., Bunnell, S., & Nagel, S. (2001). Developing goal based scenario for Web education. *Proceedings of the National Association of Interpretation 2001 Conference.* Retrieved December 5, 2006, from *http://www.eduweb.com/goalbasedscenarios.html*

Schank, R.C. (1993/1994). Goal-based scenarios: A radical look at education. *Journal of the Learning Sciences, 3,* 429-453.

Schank, R.C., Berman, T.R., & Macpherson, K.A. (1999). Learning by doing. In C.M. Reigeluth (Ed.), *Instructional-design theories and models* (pp. 160-181). Mahwah, NJ: Lawrence Erlbaum.

Schank, R.C., Fano, A., Bett, B., & Jona, M. (1994). The design of goal-based scenarios. *Journal of the Learning Sciences, 3*(4), 305-345.

Schank, R.C., Korcuska, M., & Jona, M. (1995). Multimedia application for education and training: Revolution or red herring. *ACM Computing Survey, 27*(4), 633-635.

Schoenfeld-Tacher, R., Persichitte, K.A., & Jones, L.L. (2001a). Relation of student characteristics to learning of basic biochemistry concepts from a multimedia goal-based scenario. *Proceedings of the Annual Meeting of the American Educational Research Association,* New Orleans, LA.

Schoenfeld-Tacher, R., Persichitte, K.A., & Jones, L.L. (2001b). Differential effects of a multimedia goal-based scenario to teach introductory biochemistry—who benefits most? *Journal of Science Education and Technology, 10*(4), 305-317.

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

Zumbach, J., & Reimann, P. (2002). Enhancing learning from hypertext by inducing a goal orientation: Comparing different approaches. *Instructional Science, 30,* 243-267.

KEY TERMS

Case-Based Reasoning: The theory of memory and learning which aims to explain how people remember and use their memories in order to solve new problems (Schank et al., 1999). Solving new problems by using or adapting the solutions of the old problems (Riesbeck & Schank, 1989).

Content Knowledge: "The information that achievement of a goal requires" (Schank et al., 1999, p. 173).

Cover Story: "The background story line that creates the needed mission to be accomplished. The most important thing to consider is whether the story will allow enough opportunities for the student to practice the skills and seek the knowledge you wish to teach" (Schank et al., 1999, p. 174).

Digital Game-Based Learning: This is precisely about fun and engagement, and the coming together of and serious learning and interactive entertainment into a newly emerging and highly exciting medium (Prensky, 2001).

Goal-Based Scenario (GBS): "A learning-by-doing simulation in which students pursue a goal by practicing target skills and using relevant content knowledge to help them achieve their goal" (Schank et al., 1999, p. 165).

Mission: The goal to be reached in the scenario.

Process Knowledge: "The knowledge of how to practice skills that contribute to goal achievement" (Schank et al., 1999, p. 173).

Role: "Defines who the student will play within the cover story." In defining the role, "it is important to think about what role is best in the scenario to practice the necessary skills" (Schank et al., 1999, p. 175).

Scenario Operations: "Comprise all of the activities the student does in order to work toward the mission goal" (Schank et al., 1999, p. 175).