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ABSTRACT

This paper presents findings demonstrating benefits of cooperation between Edunetics, a commercial multimedia production company, and the Plano Independent School District (Texas) that resulted in a unique curriculum integration project. The "Message in a Fossil" (MIF) simulation software was used with three pairs of second grade students; data were gathered through pre- and post- questionnaires and interviews, video and audio taped MIF sessions, and the teacher's anecdotal and assessment sample records. Findings in the following areas are discussed: (1) student learning outcomes and processes; (2) the teacher's role and the classroom computer culture; and (3) contributions to the production knowledge of the producer. The results of the study indicate a positive impact of the curriculum-tailored, interactive multimedia simulation on both the teacher's perceptions and teaching methods and student's motivation, understanding, and thinking skills. Conclusions based on the results should assist curriculum designers, teachers, and multimedia producers in achieving better integration of educational software in school curriculum. (Author/DLS)

Educational multimedia implementation in schools: Producer-teacher-student links.

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Abstract: The paper presents findings demonstrating benefits of cooperation between a commercial multimedia production company and an United States elementary school district that resulted in an unique curriculum integration project. The results of the study indicate a positive impact of the curriculum-tailored, interactive multimedia simulation on both the teacher's perceptions and teaching methods and the Grade Two students' motivation, understanding, and thinking skills. Conclusions based on the results should assist curriculum designers, teachers, and multimedia producers achieve better integration of educational software in school curriculum.

During the last decade we have witnessed a significant rise in the number of computers in schools and in the amount of sophisticated instructional software in the commercial education market. However, the integration of educational technology in school curricula still lags behind earlier expectations. Several reports and researchers [Drazdowski 1997]; [Maddux, Johnson & Willis 1997]; [Szabo & Schwarz 1997] have tried to explain this gap, usually in terms of a failure by colleges of education to expose students to educational technology and to train them adequately in this area, budget limitations, the teachers' fear and reluctance to incorporate computer technology in their classrooms, and infrastructure organizational difficulties. These explanations ignore the relationship between software producers and educational consumers (schools, teachers, and students). An alternative explanation - and solution - for the limited success of educational technology in schools involves, not just the factors highlighted above, but the mismatch between available software and teacher requirements. Because teachers have increasingly to integrate commercial multimedia products into the existing curriculum, the products can inadequately fulfill the teacher's specific learning objectives. An obvious solution to eliminating the mismatch is a collaborative partnership between software producers and teachers. Some educational multimedia software companies acknowledge the possible mismatches and employ ex-teachers or consult practicing teachers. However satisfactory this practice may be in the resultant stand-alone educational CD-ROM, it still ignores the need for significant systemic and curricula rethinking and restructuring between the stakeholders and within their organizations: the software company, school boards or government education departments, individual schools, and teachers.

Such creative restructuring occurred between an educational multimedia producer and an American school district, its schools, and teachers. In 1993 the Plano Independent School District (PISD), Texas, decided to shift the teaching methodology and segregated discipline-based curriculum of its elementary school system into a thematically integrated, computer-based curriculum [Jacobs 1989]. Edunetics, a multimedia production company, was contracted to help redesign the curriculum, inservice teachers in the area of computer technology, and develop educational computer software that would serve as the backbone of the new integrated curriculum. The participating K-5 teachers were released part-time to work cooperatively with the pedagogical and content experts in Edunetics. Together they identified 36 topics based on six themes stipulated in Texas-wide elementary curricula and structured around different core Organizing Ideas. In essence, the production process was designed so that the PISD teachers expressed their curricular needs. The multimedia company was responsible for translating those needs into a computer product. The collaboration represents a unique enterprise where an educational software company and teachers equitably shared decisions to produce digital and non-digital educational products that focus appropriately on curricula needs. Through such cooperation, the teachers were empowered through having a major stake in the conceptualization, content, and user-learner interface design of each CD-ROM.

Our project was not concerned with ascertaining whether learning with particular software produced better test scores than learning without the software. Rather, the research examined the incorporation of educational multimedia as part of a newly-designed integrated curriculum in the "messy" environment of a classroom over a period of time. The researchers were interested in how the use of the software impacted the classroom teaching-learning community. The paper focuses on particular aspects of the wider research, distinguishing between findings which contribute to (a) a clearer understanding of the learning process in an authentic context, (b) the teacher's role and the classroom computer culture, and (c) the production knowledge of the producer.

Methodology

The qualitative interpretive research was designed to assess aspects of the educational implementation of the PISD curriculum integration project. Dependability and confirmability of the data were enhanced through triangulation of varied data collection instruments; site engagement for the six week duration of the integrated curriculum unit; and researcher observations authenticated by video and audio taped data.

The research was conducted in a Grade Two class in one of the PISD participating elementary schools in Plano during the Spring quarter. The teacher had trialed the Beta version of “Message in a fossil” (MIF) in her Grade Two classroom two years before, and used the final product in the year previous to, our research. The class was chosen because it was the most ethnically and socio-economically diverse compared with those of the other volunteering teachers; even so, it was still significantly middle America. From the 20, seven year old students, the teacher was asked to select three, same-sex groups of two children based on ability. The study used these pairs for indepth study. The outcome of the teacher's selection was one pair of two high achieving female students; one of two low achieving male students; and the third comprised two male students, one high achiever and one low achiever. Based on research [Inkpen 1997]; [Inkenpen, Booth, Gribble & Klawe 1995), it was thought that for the scope of this investigation, mixed gender groups would provide one too many variables.

The software, MIF, is a simulation [Rieber 1996] in which the student is a paleontologist who excavates in virtual grid dig-sites, discovers plant and animal fossils, predicts what they might be, identifies them by comparing them with those in the fossil collection, and, based on the uncovered fossils, reconstructs the prehistoric world by constructing a museum diorama. In this interactive environment, the student emulates a scientist and practices science skills. "Message in a fossil" was incorporated into a six week integrated curriculum unit with "Evidence" as the Organizing Idea. The major theme of the unit was gathering, interpreting, and communicating evidence to solve mysteries and problems, particularly those that inform our understanding of the past. For approximately 45 minutes each day, the class worked in stations where each small group activity integrated the Organizing Idea and theme across curriculum areas. One of these daily rotating stations was learning with MIF. The teacher also included MIF into the time allocated for reading. This meant that each student used the software each day for 20 minutes during reading, with some using it twice a day during their station activity time. In addition, when they finished other work children could choose to work with MIF, if a computer were free. The classroom had seven computers and a printer that were networked to a fileserver through which the children accessed the software.

Global data were obtained from pre and post, written and interview questionnaires with the students and teacher. The student written questionnaires were administered by the teacher who read out each question at a suitable answering pace for the children. The researchers felt that it was appropriate for Grade Two children to have test items that utilized hands-on activities which were administered via pre and post audiotaped interviews. Pre and post audiotaped, flexible open-ended structured interviews were conducted with the teacher. Data were also obtained from the teacher's anecdotal and assessment sample records. Indepth data were obtained by narrowing the research focus to the small sample of six students. Each student in the three paired groups was administered a pre and post open-ended structured interview. Additionally, each pair was video and audio taped and observed whilst working together on the computer: twice in the first week and once a week for the following five weeks. Based on the recorded observation notes, retrospective recall interviews were conducted by a researcher with both students at the end of each video and audio taped MIF session in order to prompt recollections of their thinking, reasoning, strategies, and feelings during the activity.

RESEARCH FINDINGS AND ANALYSIS

Student Learning Outcomes and Processes

Some of the findings are grouped into the following subthemes: acquisition of scientific concepts and processes; independent decision-making and conflict resolution strategies; and motivation and enthusiasm.

The first subtheme grouping is the students' acquisition of scientific concepts and processes. From the pre and post questionnaire test items, there was a 28% improvement in students' scientific conceptualization and processes. From the data it is clear that all the children could correctly identify a fossil from rocks at the end of working with MIF and the other Organizing Idea integrated curriculum activities. However, only 56% could verbalize how a fossil was formed. Although there was a video about the formation of fossils in the software, less than half the class appeared to have visited that site other than during the whole class tour.

Comparison of the pre and post tests revealed a significant improvement in the students understanding of the complex concept of decay and longevity. They were required to identify which of six items (an apple, wooden door, shark tooth, bread, a sea shell, a book), presented as labeled pictures, they could still dig and find if the items had been buried a long time ago. Of the six items, two were correct. Out of a possible 36 correct answers (2 questions by 18 children), 35 correct answers and 1 incorrect answer were recorded in the post test. This was a substantial improvement on the pre test results with 26 correct answers and 37 incorrect answers recorded.

There was improvement in the students' ability to sort items into logical categories. Logical categories included such things as "mammals" and "have fur" whilst illogical groupings were given labels like "all part of nature" and "the remaining animals". Out of 18 students, nine provided significantly more logical groups out of their total number of groups in the post test compared to what they had in the pre test. Seven students had the same number of logical categories in the pre and post interviews whilst two gave fewer logical groups in the post test. We also analyzed the students' answers in terms of the scientific groupings used in MIF. In the post test, all students used the criteria utilized in the software, with six using more software criteria in the post test compared with the pre test; three students used fewer categories in the post test. It would seem that MIF and the other activities helped most students internalize what constitutes logical and scientific criteria and how to appropriately categorize that criteria.

The simulation, MIF, required the students to construct dioramas with fossils found in various habitats. To ascertain their ability to conceptualize which fossils belonged in the same habitat, the students were presented with four labeled pictures of fossils and asked to identify the fossil that did not belong in the same habitat as the other three. There was an improvement of 17% from pre to post test.

The results of the children working with the same partners with MIF for the six weeks are worth comment. On the days when the research was not being conducted, the students either, with few exceptions, chose the same partner or worked individually (Student interviews). There was an improvement in results from pre to post tests. In comparison with the classroom results some items revealed a significant difference. For example, as mentioned above, explaining how fossils were formed was answered poorly by the class; this makes the post test results for the pairs significant: 80% of the five students (one did not do the post test) answered correctly in comparison with 45% of the rest of the class. It is possible that the interactions between relatively permanent partners when working with MIF may have helped their understanding.

An analysis of an individual writing activity on dinosaurs and fossils that was set by the teacher at the end of the six weeks reveals internalization of content. The target was three facts - which they all achieved - and as much as they could write in five minutes. As the teacher pointed out, the topic was of "very high interest to them" so the quantity was no real surprise. Their answers did not reflect the traditional focus on listing the names of dinosaurs and the facts. They wrote more generally, even the lower achieving students. They talked about evidence and problem solving as well as correctly using paleontologist, diorama, and interdependence (a "buzz word for them"). Their writing included such things as: using a digging grid; measuring and labeling fossils; fossils were evidence that dinosaurs existed; "if you want to find out about them you can look at fossil remains"; the fact that "dinosaurs lived a long time ago and that some lived in the ocean and some on the land". A few students included the idea that dinosaurs and people did not live at the same time. Their writing overall contained high level information and embodied concepts presented in MIF and the other integrated activities.

Working with partners with MIF promoted student independent decision-making and conflict resolution strategies - the second subtheme. The teacher gave an example of the former: "Knowing where to go next, when to proceed to the next level of difficulty, and what to do if they couldn't finish their diorama at a single sitting, they totally took care of that themselves. And I've never had a group like that before. Usually, I spend the first few weeks hovering, giving directions." The students also resolved potential conflict issues about who to work with and how to work together equitably. For instance, sharing control of the digging and building the diorama were quickly decided and occasionally renegotiated amicably between the female and the high/low achieving male partners. However, in the second week the low achieving male partners took their shirts off and threw a few punches. As commonly reported in the literature (Inkpen, et.al., 1995), one of them explained that "we were trying to fight over control"; each took credit for solving their dilemma by being the one to establish taking turns on the mouse after each fossil find.

The third student learning outcomes and processes subtheme is motivation and enthusiasm. What the preceding discussion does not provide is any sense of the atmosphere or what occurred in the classroom learning community during the six weeks. The students' unanimous perceptions were that "you learned a lot" working with MIF, which was "cool", "lots of fun", "interesting", and "never boring". Data from the interviews, observations, videos, and teacher records confirm a consistently high level of enthusiasm, on-task behavior, friendly competition, supportive cooperation, use of appropriate language, and transference. There are three major interrelated reasons for these ingredients in the classroom learning climate and outcomes.

(i) Working with partners on MIF was the reason the teacher singled out as probably the most significant. All students mostly worked with partners and, depending on how they felt or the availability of their partner, they would choose to work with another person or, occasionally, alone. The six teacher-selected students were also allowed to choose other partners or work alone during non-research times. Irrespective of the set-up, there was discussion, requests for help, and unsolicited advise, between partners and neighbors as well as up and down the computer row.

In comparison with previous years, working with partners "made an incredible difference." Previously, it took the six weeks for any student in the participating schools to complete a certificate and it was "really frustrating for them ... I have never had anyone do expert level before." This year in the research class, there were certificates and dioramas at the end of the first week; by the end of the unit, a whole classroom wall was covered and all students had got to the expert level of difficulty. This permitted "better internalization of the vocabulary. They were not just listening by themselves; they were communicating" their understandings. Having partners "kept them focused" and provided "security so they could take risks" in their decision-making

(Teacher post interviews). Working with partners also seemed to have an effect on the classroom learning culture: "They all wanted to get the dioramas and they wanted to get the certificates. But when someone put up a certificate everybody would hover around them: 'What did you get?' 'What did you put in it?' 'Where did you find it?' You know, they really were interested in a very positive way, a very supportive way." (Teacher post interview). There was not so much a competition as a collaboration.

(ii) MIF itself promoted motivation and enthusiasm. The user interface design is unproblematic with meaningful navigational icons, and is enticing. The learner interface [Reeves 1993] contains various pedagogic elements that may have been influential in the children's learning outcomes. The software provides the necessary intrinsic motivational ingredients for an effective simulation: challenge, curiosity, fantasy, and control (Malone 1981]; [Rieber 1996). The children were "actually in control; they had so much ownership of it" and "felt like they were scientists doing it ... it was very real life for them" (Teacher post interviews). The challenge for self-improvement triggered further reading in order to do better in MIF. A number of students researched dinosaurs and fossil-related topics at home in order to "learn more about how to put the bones together" or "know what some of the things were when I got onto MIF."

(iii) The final contributing reason to student motivation and enthusiasm was the integrated curriculum. The teacher believed that MIF would produce meaningful learning outcomes if used as a stand-alone but its real value was enhanced through appropriate curriculum integration of software and other classroom activities. Indeed, one of the girls in the research pair explained that one reason she enjoyed MIF was "because it fits in with our integrated [sic]." The teacher further elaborated: "Even though Communication was the Overarching Concept and Evidence was our Organizing Idea, it was almost like 'Message in a fossil' was the organizing idea. It was the heart of everything." The teacher believed that this allowed them to make bigger connections within and between the activities.

The Teacher and the Classroom Computer Culture

This study identifies the teacher as a key component in the successful incorporation of computers and multimedia into the classroom. Her three year involvement in the PISD project had strengthened the teacher's enthusiasm for incorporating computer technology in the classroom: "I think it's the most wonderful thing that has happened ... and having the software that supports our curriculum has been fantastic, because it really makes a difference, particularly in what they [the children] like." Obviously, the number of computers was a bonus that supported the computer culture.

The research influenced the teacher's usual practices with respect to individual versus partnered work with the computer. Previously, all the PISD teachers using MIF decided that there would be a one to one ratio of child to computer: "We have wanted everyone to have, this American thing, you know, their own dig site; they had to own it." Because of our research request, the teacher changed strategies and organized for the remaining children to choose their own partners or work alone. During the post interview the teacher argued that partners allowed her to put into practice her pedagogic philosophy to maintain a facilitator role with an emphasis on student responsibility for their own problem solving. Instead of directing, data revealed that the teacher asked questions in response to the students' questions. Even when the paired low-achieving students resorted to throwing punches, the teacher suggested they solve their conflict in non-physical ways and (seemingly) confidently walked away. At the end of the six weeks, the teacher was adamantly committed to using partners when working with MIF and other similar computer software because "I can see nothing but benefits."

Contributions to the Production Knowledge of the Producer

The findings have practical and economic implications for multimedia producers. "Message in a fossil" is a pedagogically effective simulation, and could be viewed as an exemplar. Importantly, if the questions that were answered poorly on the post test are of curriculum significance, for example, how a fossil is formed, then they need to be woven into the simulation more substantially. Teacher support materials could contain possible strategies for student to computer ratio usage.

Another issue for multimedia producers concerns a post questionnaire item that required students to link a picture of the computer interface icon with its topic label (eg., Museum). Half the students incorrectly matched some of the icons. These incorrectly identified topics (including fossil formation) were extraneous to completing the diorama or achieving the three certificate levels. Only seven students said they visited these topics. This implies something about the willingness of students, at least Grade Two students, to diverge from the mainstream of the simulation activity. In such cases, the educational multimedia producer has options: if the content is considered important, then it needs to be a mandatory part of the simulation rather than nice-to-have extension activities; decide to exclude these non-simulation sections thereby cutting production costs; or produce a multipurpose CD ROM, like MIF, that combines a simulation with an extension database for multi-age level usage.

Conclusion and Challenges

The research suggests that producer-teacher cooperation in the planning and development of interactive multimedia products has a number of positive outcomes that could help redress the reluctance by schools and teachers to incorporate more extensively educational software into the class curriculum. First, the software that was produced proved well-tailored to curricular, teaching, and learner needs. Second, classroom implementation of the software in the way in which it was intended, ie., within an integrated curriculum, produced positive outcomes in terms of students' content knowledge and process skills and the teacher's teaching strategies. Third, the interactive multimedia simulation and the use of computer partners promoted a classroom computer culture and learning climate that was enthusiastic, motivated, and cooperative. Of course, there are limitations in generalizing this study. To augment the findings, further research is planned in various classroom contexts; for instance with differing cultures and grades, teachers with little to advanced computer expertise, and using the software as a stand-alone activity compared with its incorporation in an integrated curriculum.

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