# Teachers as Game Designers: Lessons from a Collaborative Learning Exercise

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## ABSTRACT
Computer-supported education is increasingly becoming common in schools across the world. Accordingly, teachers are being trained to better utilize computers as a pedagogical tool. This training ranges from the physical operation of a computer to teachers learning to create and present digital versions of their own learning materials. In this paper, we report our experiences from an exercise conducted in India to help twelve 9th and 10th grade teachers design games that promote collaborative learning. Specifically, we describe a strategy for designing collaborative learning games through active teacher participation. We also present four key elements that are essential for teachers to successfully design games for learning: (1) the affordances of the technology for which they are designing; (2) a vision of how the games will be incorporated in the teacher's daily lessons; (3) the concept of games and interactivity; and (4) a nuanced understanding of the pedagogical goal.

## Categories and Subject Descriptors
H5.2. [Information Interfaces and Presentation]: User Interfaces - Input devices and strategies, Interaction styles, Evaluation/methodology.

## General Terms
Design, Human Factors

## Keywords
Participatory design, single display groupware, shared computers, education, multiple mice

## INTRODUCTION
A great challenge for secondary school teachers in India is teaching the first principles of advanced concepts to their students. This problem is most pronounced in the 9th and 10th grades where core subjects such as the Arts, Science, English and local language courses make a sharp transition into advanced content [11]. For example, basic science classes split into Physics, Chemistry and Biology and students, for the first time, encounter the more complex principles of each subject area. What complicates this situation further is the widespread practice of rote teaching and learning in India. This pedagogic approach provides teachers and students little opportunity to address misunderstandings or entertain tangential questions, which may lead to an informative discussion.

To address this problem, the National Council of Education Research and Training (NCERT) [11], a government organization helping to shape India's education through curriculum and policy development, has embarked on a project to revolutionize how learning occurs in Indian schools. They want to move away from a rote-learning system to a collaborative learning one. Collaborative learning is grounded in the social constructivist theories of Piaget and Vygotsky [6,9,10]. It advocates learning in small groups where through the sharing of opinions and ideas, students engage in the social process of knowledge construction and discovery. The teacher acts solely as a facilitator, providing minimal instructional guidance to the students. NCERT considers this to be the right anti-dote to the problem as students would be encouraged to tackle the complex principles with the help of their peers.

Given the increasing availability of technology in classrooms in developing regions [1], NCERT decided to rely on computer games to implement its collaborative learning plan. It selected MultiPoint [13], a technology that allows two or more people to concurrently use the same application on one machine. It chose MultiPoint for two reasons: (1) it has been proven to work in resource constrained environments [5]; and (2) it has been shown to provide positive learning gains when used for collaborative learning [4].

In this paper, we describe a case study conducted with subject teachers for designing collaborative learning applications for use in schools. The primary goal that this study wanted to address was to form a design strategy to involve teachers actively in the process of designing collaborative games. A particular gap in educational technology today is that teachers don't successfully incorporate technology into their curricula [14] which is largely considered to be a result of the fundamental disconnect that they feel when a piece of technology is handed over to them which they have little say in. This calls for an improved model of game design with active participation from the teachers. One can address this by eliciting information from the teachers on the subject content they feel should be addressed by the games and conveying this information to the game designers who can in turn come up with engaging games. However, we contend that a deeper level of participation is needed from the teachers for three reasons - 1) In a model where teachers convey their requirements to the designers, it is imperative that the designers understand exactly what the teachers want and consequently the teachers should know the level


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of detail they need to go to, to achieve what they envision as the purpose of the games. 2) The teachers should feel a sense of ownership of the games and consider them as part of their lesson materials which can be best achieved if they have actual ownership of the designs underlying the games. 3) Concepts such as collaborative learning through the use of computers are difficult to grasp for teachers initially. Consequently, even if they are willing to make use of a particular collaborative game, the teachers should have a first-hand understanding of what the students' experience should be like in order to extract benefits from the game. While participatory design procedures for games have been studied before [7,8], this case study operates under a different context, with a specific pedagogical goal of collaborative learning.

We discuss lessons from our exercise which clearly indicate that aside from knowing the technology, the teachers require a set of pedagogic and implementation knowledge to make the design process successful.

# METHOD

NCERT's plan was two-fold: first, to convert textbook exercises into MultiPoint-enabled collaborative activities that groups of students could interact with. Second, was to train teachers to translate textbook exercises in their subject area into game designs of collaborative activities that the games designers could refine for implementation.

To achieve NCERT's goals, a 4-day workshop was organized in July, 2009 to prepare the teachers. The participants were twelve $9^{th}$ and $10^{th}$ grade teachers from 4 subject areas: Chemistry, English, Geography and Math. They were nominated by their school boards as teachers open to using technology in their teaching. They came from different parts of the country and taught both in rural and urban schools.

## Workshop Design

The main aim of the workshop was to train the teachers to design collaborative games from textbook exercises with the aid of a stepwise design strategy. To achieve this we needed to familiarize them with MultiPoint and collaborative learning. Subsequently, the workshop consisted of a technology phase, which included an introduction to the technology; a thought exercise on using games in the classroom; and an initial game design exercise. The second phase was focused on pedagogy and discussions on how to effectively practice collaborative learning in the classroom.

To give the teachers a first-hand experience of the pedagogy at work, the entire workshop was organized as a collaborative learning exercise. The teachers worked in groups of four based on subject area, and each group had an expert who acted as a facilitator - just like a teacher would be for the students in real classroom. They were required to collaborate and discuss in their groups and produce certain deliverables in the form of PowerPoint presentations of their ideas. The idea was that in the process of co-developing games, they notice the value of collaboration. n addition to give the teachers an immersive experience with the technology, they were given MultiPoint games to play instead of plain demonstrations.

For a particular subject, every teacher might have a different opinion on the topics they would want to address in a particular subject and on the design approach to be taken. Hence to make the design more conformable to have a wider acceptance, the teachers were selected from schools in different regions in India. All teachers of a particular subject taught the same course material.

The idea of teachers forming PowerPoint presentations was decided to enable the group to work together towards a single chain of thought. Also, this would help them visualize their ideas and render a conceptual clarity to them in the process of making a formal presentation. In addition, most teachers were experienced in working with PowerPoint. In the long run these presentations were envisioned to help with implementation coding so that the developers can understand the thought process that went into the final designs.

The workshop was designed to ensure that the information did not overwhelm the teachers. While conducting the workshop we encountered interesting and unexpected outcomes, which required changes to our initial design. We will describe the phases in detail in the Workshop section.

# WORKSHOP

In the beginning, the teachers were explained about the goals of the workshop, how they would be working and the deliverables they need to present.

## Technology Introduction

Initially, the teachers were introduced to MultiPoint. They were shown a demonstration of how it enables shared access to a computer and how multiple students can play together. The groups were then given a system each to play sample games on their own while they were being assisted by an expert all the time if they came across any doubts. The sample games here refer to applications typically comprising animated storylines followed by MultiPoint games ranging from the racing, split-screen models to turn-taking and unity [3]. A more detailed overview of the content of these games is available in the following papers [2,4,5].

## Conceptualizing Usage

After the above session, each group was asked to discuss and come up with a single topic from their curriculums which they all felt students have problems understanding and for which they would like to be assisted by computer games. In addition they were asked to think about how they would want to incorporate such games in their lesson plans – would they want to use it before/after they have taught the lessons in class or would they want to teach such topics in the computer lab itself while having the children play. All the teachers soon came to a consensus on the topics. As evidenced by the experts that sat with the groups, we found out that there was little contradiction amongst the teachers regarding the suitable topics and much of the discussion went into selecting which of those they should select based on how effectively it would translate into a game.

## Design Exercise

The next exercise for the teachers was to conceptualize multiuser games based on the topics they finalized upon. At this point, we had assumed that the teachers would adopt some form of the sample games they had watched and played for their specific contents. However, none of the groups followed the gaming style depicted in the samples. The chemistry teachers picked to explain the structure of atoms followed by how its structure affects chemical reactions and their balancing. Their approach was to show an animation that conveys the concept followed by a multiple choice question. This question would be displayed in all parts of a split screen based on the number of students sitting on

the computer. Figure 1 shows a PowerPoint slide made by the chemistry teachers to illustrate their conceptualization.

What was interesting in the outcomes of this exercise was that the underlying concept behind each of their ideas was very similar – an initial animation followed by a Q&A. This leads to two interesting insights – 1) Teachers were thinking strictly in terms of the textbook approach they use in the classes where a chapter is followed by Q&A exercises. 2) In this context, teachers viewed the computers more as a display tool, rather than an interactive medium and therefore found ways to effectively translate chapter content into animations, but not the exercise content into games.

## Added Step: Introduction to Interactive Gaming

Before we could begin the pedagogical goal introduction phase, we had to make sure that teachers understand the difference

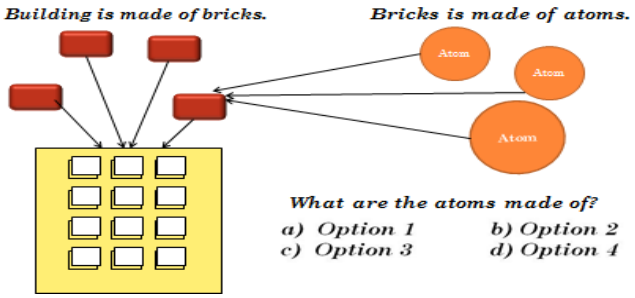
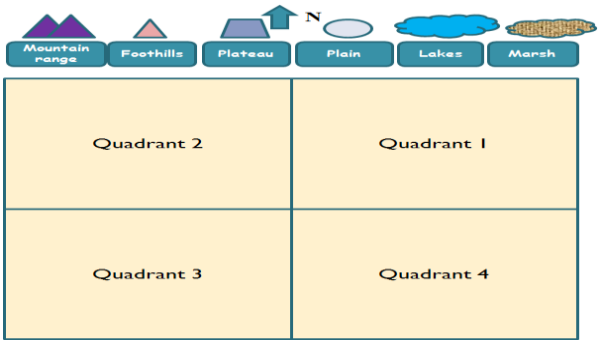



**Figure 1: PowerPoint slide made by Chemistry teachers initially**

between Q&A and interactive gaming. Consequently, we added an intermediate phase to explain the use of computers as an interactive medium and how the teachers can build interactive games which involve and interest the students. To evidence this, we gave demonstrations of the interactivity features employed in games, such as – making the overall storyline in the application contingent to the outcome of each game, transforming Q&As to visual/word puzzles or riddles, giving the students tasks of a certain difficulty level to serve as a challenge and consequently increase immersive interest. A second round of conceptualization took place after this.


*(a)*




*(b)*

**Figure 2: PowerPoint slide made by (a) English and (b) Geography teachers after interactive games were discussed in the workshop**

There was considerable improvement in this stage as the teachers had moved away from the Q&A exercises and were attempting to build activities that would warrant more student attention and response. While previously the English teachers took a noun and gave four adjectives as options to the students, this time each student was to be given a different noun for which they had to choose all the possible adjectives from a given common list (Figure 2(a)).

The concept presented by the geography teachers (Figure 2(b)) was somewhat similar with a greater level of graphic visualization, where each student had to create a landscape using the given icons.

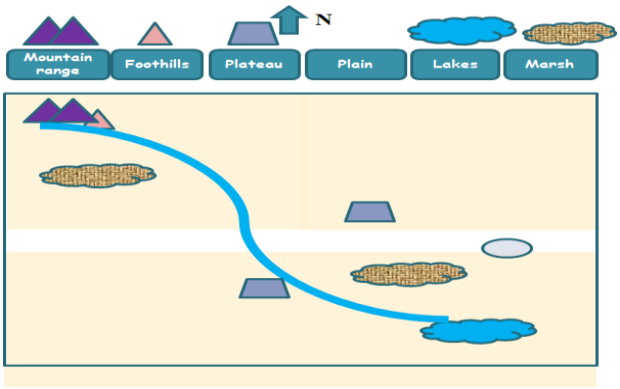
After this phase it was evident that the teachers had somewhat warmed up to the concept of using games to teach educational content and were performing well in designing such games. However the games were not collaborative.

## Pedagogical Goal Introduction

In this phase we introduced the concept of collaborative learning through games. Collaborative gaming primarily involves discussions among students while playing the games to achieve a single goal. We discussed this point with the teachers and gave demonstrations of various collaborative games and how they incited collaboration. We then gave them systems to play various MultiPoint collaborative games and observe the kind of interactions that took place amongst themselves (Note that the games had already been introduced to the teachers in the first phase, but to add to their understanding on collaboration, a second round was held, concentrating on the collaborative aspects). There was visible excitement in this session when teachers started collaborating amongst themselves to play, thus realizing the experience that the students needed to go through in process of learning the concepts.

## Final Design Exercise

The games formulated by the teachers in the final exercise were definitely directed to generate collaboration among students.

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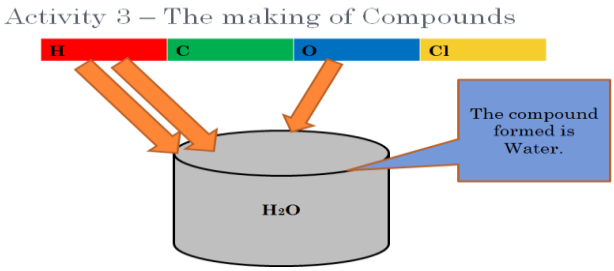


(b)

**Figure 3: Final PowerPoint slide made by teachers (a) Geography (b) Chemistry**

The geography game now involved the construction of one screen-big landscape using the icons, which would lead to student discussions about the positioning of each icon on screen (Figure 3(a)).

The chemistry teachers formulated a game for the students to construct a compound using the list of elements and balancing the equation, thus opening the possibility of inciting discussions amongst students on which elements to be used in what proportions (Figure 3(b)).

The final exercise yielded rough designs which were not the polished, detailed prototypes that are needed for the implementation, but they served the purpose they were meant for – they were collaborative games indicative enough for the game designers to take over. More importantly, 1) the teachers had accepted collaborative learning as a valid approach which can add to their classrooms significantly in certain portions of their courses. 2) Given that they were active participants in the design process ensured that they were clear as to how to they would use these games in their classes so as to extract maximum benefit for the students.

## CONCLUSION

We described a participatory game-design process for developing collaborative educational games which has teachers designing the games themselves.

The workshop helps us formulate certain prerequisites (technological and pedagogical) that are imperative for the teachers, besides knowing subject content, which should always be addressed while pursuing educational game design with teachers – The teachers should have an understanding of 1) the technology – what it can or cannot do – it's benefits and limitations 2) a vision of how they would use the games in their classrooms, 3) the concept of games and interactivity and 4) the pedagogical goal being tried to be achieved, its merits and the various ways to incorporate it (in our case collaborative learning).

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