Children Learning Filmmaking Using Multimedia Tools

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Abstract: Children watch lots of TV and movies, but they rarely make films. This is because the production process is complex, the result is hard to visualize, and one must use and integrate textual, audio, graphic, and video media. Computer-based multimedia facilitates idea development and visualization, and affords the integrated handling of multiple media, so it should aid movie creation and production.

This paper reports on the use of our Movie Authoring and Design (MAD) multimedia system in a summer camp. We wanted to test if this system and the process of motion picture creation could be quickly learned and effectively used by school children. MAD and a control condition of conventional digital editing tools proved to be useful for and usable by eight groups of 3 seventh graders to achieve proficiency and make 2 movies each in the space of a week. The paper presents both quantitative and qualitative data illuminating the children's accomplishments, learning process, and determinants of success, and also the influences of prior experience, counselors, and technology.

Keywords: Multimedia, filmmaking, children making movies, educational software, collaborative learning, empirical studies, qualitative methods, within-subjects experiment.

INTRODUCTION

Children today spend significantly more time watching TV and movies than they do reading. Yet students are not learning to express themselves in the dominant media:

> "The essential medium of expression in the classrooms is no longer print. It's a hybrid of print, video, audio and video games, but unless we provide access to the tools to compose in this medium, we will be training students to be readers but not writers. And if all they do is read these multimedia texts, not only will they have sore eyes, they will be missing out on an important part of what it means to be literate." [Reilly 96]

There is very little literature (but see [Buckingham 90; Paley 95]) describing studies of children creating media. An exception is Reilly [Reilly 94, 96], who documents innovative uses of multimedia authoring at several California high schools as a part of the Apple Classrooms of Tomorrow program. The students create video essays, music videos, and public service announcements, using conventional text editing software and video editing equipment.

Our Movie Authoring and Design (MAD) system [Baecker et al. 96; Baecker et al. 97; Cohen et al. 96, Friedlander et al. 96; Posner et al. 96; Rosenthal and Baecker 94; Rosenthal 95] was designed to assist hierarchical development and organization of movie ideas and components — scripts, pictures, audio, and video, to support their manipulation in a unified manner that is easy to learn and use, and to aid visualization of the ultimate result. It can therefore assist both experienced and novice movie makers, including children as young as 11 years old.

We believe, as does Reilly, that children benefit by being able to express their ideas in movies, and that digital media can provide rapid learning opportunities and access to filmmaking tools previously reserved for experts. We wanted to study and test these hypotheses in a controlled but realistic setting. We also believe that the idea development, organizational structuring, and visualization capabilities of MAD provides benefits above and beyond those present in conventional consumer digital video editing. We therefore decided to study children's usage of MAD compared to "conventional" digital editing software.

Our report begins with a description of the capabilities and uses of MAD. We then describe the study setting, hypotheses, and experimental method and data sources. Results are presented and discussed organized into six areas — accomplishments, movie quality and experience, moviemaking process, effects of software and counselors, and success determinants. This paper focuses both on quantitative results and on qualitative data resulting from an analysis of video tapes, and is a companion to [Posner et al. 96], which provides more quantitative results and is an extended version of the hard copy paper [Posner et al. 97].

SOFTWARE FOR MOVIE AUTHORING

MAD is the first system that allows the design and management of words, images, sounds, and video for visualization during the pre-production and production phases of a motion picture. Key design goals were:
• *Hierarchic idea structuring* — the ability to develop movie ideas both top-down and bottom-up, to modify the structure with ease as new ideas arise, and to work at whatever level of detail is desired.
• *Multimedia support* — the integrated handling of scripts [Fig. 1], dialogue or narration, music, sound effects, storyboards, and video shots, and of commentaries on these elements, all tied to the underlying hierarchic film structure.
• *Visualization* — the inclusion of aids to visualizing the film, as for example being able to request a real-time preview of the movie or an approximation to it at any stage in the film development process.

MAD differs from other pre-production filmmaking tools such as script writing software by including multimedia support and visualization capabilities. It differs from other multimedia authoring tools in providing stronger support for film narrative and dialogue structure [Baecker et al. 96].

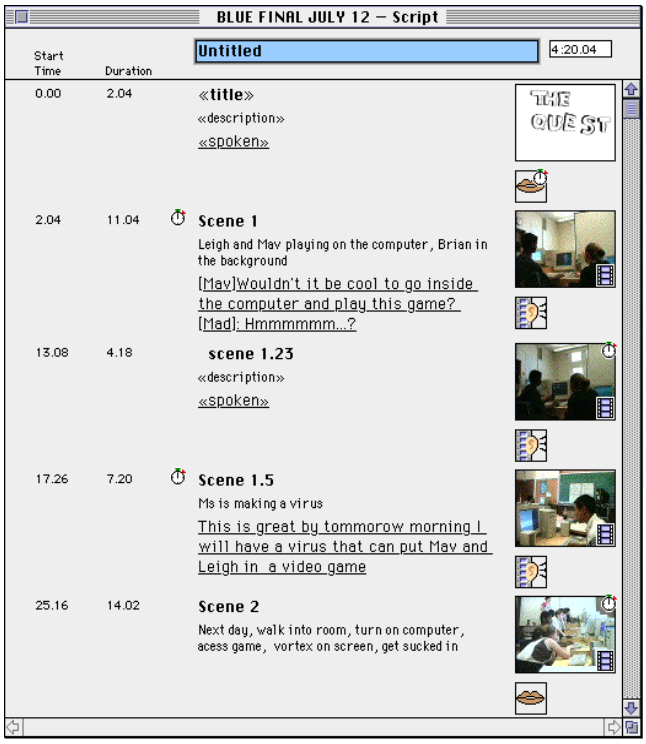

Figure 1: MAD's script view. Timing information is in the left column. The central area displays script details — scenes and shots, director's notes, narration and dialogue. The right column indicates the video and audio components of the movie, as well as annotations. The example here is from the movie *Quest* (see [Case Studies] below), a film produced at the summer camp.

MAD is a versatile tool that can be used for many different purposes including:
• Sketching, designing, thinking about, blueprinting, authoring motion pictures
• Developing, presenting, and selling film, video, advertising, and multimedia concepts
• Brainstorming, planning, structuring, and executing lecture-demonstrations and multimedia presentations
• Kids making films. Teaching filmmaking to novices; novices learning filmmaking
• Facilitating reflection on and dialogue about classroom practices by students and teachers [Cohen et al. 96]
• Multimedia messaging over the Internet.

THE STUDY AND THE HYPOTHESES

Our work is a study of filmmaking using multimedia tools in a multimedia summer camp for 7th graders. As movie production is typically collaborative [Gidney et al. 94], we divided campers into groups so that they could share ideas and the work. We used high school students as counselors and technical support staff to provide guidance

and technical support. In our pilot pre-camp we discovered that children could complete a movie with MAD or with the control software in under two days. This allowed us to design a within-subjects study in which each group would make one movie with MAD and another one with the control software.

We hypothesized that children would learn quickly to make movies using digital filmmaking software. In particular, we hypothesized that MAD would prove to be both useful and usable for this task.

With respect to conventional consumer digital editing software, we felt that filmmakers using MAD could work faster and would experiment with more variations of their movies. Because using MAD should allow authors to focus on the high level structure of their movies at all stages of the creative process, we believed that this should lead to better movies. Finally, we hypothesized that users should have positive attitudes towards the software and show preferences for MAD over the conventional consumer digital movie editing software.

METHOD

Hardware and Software

The Multimedia Summer Camp was run at a new multimedia laboratory at the University of Toronto Schools (UTS), a school known for excellence. The lab was equipped with networked personal computers and camcorders.

The experimental software was MAD 2.4 running on Macintoshes with system 7.5 and Quicktime 2.0. For the control condition, we attempted to simulate "conventional video editing" with two VCRs by using software [QuickMooV 95], which provides minimal functionality of selection, cutting, and pasting of digitized video segments. Both software conditions had to digitize their analog video from the camcorders to the computers, using Apple Video Player [Apple 95], and to compress large video files, to maximize usable disk space.

Participants

Counselors and support staff consisted of six high school students. The four counselors were 2 males and 2 females, 2 grade 11 and 2 grade 13 students. The technical support staff were male grade 11 students with extensive computer experience. All staff went through a pre-camp, where they were able to use the software to make their own movies, and then to supervise groups of campers, grade 7 students from their own school, to give them experience with this type of counseling.

The campers were 24 grade 7 students who were selected randomly from 230 applicants, 9 females and 15 males (one female was unable to attend due to illness). All applicants were 12 and 13 year old students from a suburban Toronto school district. Their computer experience varied from no experience at all to 9 years of computer usage.

Camp Process

The camp was run for two weeks. Twelve campers attended each week — 5.5 hours per day for 5 days. The campers were divided into four groups; we controlled for computer experience and gender, and tried to ensure that group members were from different schools.

Each group was assigned a counselor and a software condition for making their first movie, which they were told was to be a movie about themselves. All groups were given a brief talk about moviemaking and a demo of the software. They were then allowed to work on their movies at their own pace under the guidance of their counselor. The groups spent between 5 and 9 hours working on their first movies.

After the completion of the first movie, there was a showing of all films, followed with a lecture by a professional movie maker on various aspects of his work. This talk included a discussion of some of the problems that were encountered in the first movies — bad sound quality, unimaginative camera work, sloppy editing.

Next, our original groups of campers were assigned a new counselor and new software for making their second film, on a topic of their own choice. Another demonstration of the new software was conducted. The groups spent between 5 and 11 hours working on their second movies. On the last day of camp there was an awards ceremony with prizes. Every camper could take home a VHS copy of their work to show family and friends.

We also included Internet surfing and computer games to enliven and enrich the campers' breaks.

DATA COLLECTION AND MEASURES

We collected large amounts of data using questionnaires, audio and video journals, digital records, paper artifacts, and group discussions.

Expertise and Accomplishments: A background questionnaire asked about campers' experience with technology (e.g., video games, VCRs, video cameras), computers, moviemaking, other interests, and group work experience. The campers' knowledge of moviemaking was also assessed three times throughout the camp [Posner et al. 96].

After each movie, the campers filled out a questionnaire asking about their experiences with the software and with their group. Post-movie group discussions also addressed campers' experiences and concerns.

Movie Structure: We collected and preserved their paper artifacts including rough notes of brainstorming ideas, storyboards, and scripts. We gathered the original footage filmed by the campers and kept VHS copies of all final films for evaluation and analysis.

All digital records and files were saved (approximately 600Mb/movie); these included scripts, digitized video segments, and versions of the evolving movies. We also analyzed movie and script structure using a detailed quantitative evaluation form [Posner et al. 96].

Movie Quality: The quality of the movies was rated by three "experts" — one movie maker and two avid movie viewers. They used three categories (technical merit, creative ideas, and overall impression) and a five point scale (excellent, very good, good, fair, poor). We used the sum of the ratings of the three experts as the score in each category; for example, the overall scores for the sixteen movies ranged from 3 to 15. The sum of the three categories produced a total score ranging from 12 to 44 (out of 45).

Process: For recording the moviemaking process, the counselors kept records of their groups' work using paper activity calendars and audio journals. We also collected video journals that contain the first two hours of work on each movie, six of which have been analyzed for this paper.

To visualize the process information we plotted the groups' activities by combining calendars, audio journal transcripts, observers' notes, and digital time stamps on files according to the following categories: brainstorming, script writing, filming, digitizing and compressing, editing, Internet searching, and miscellaneous.

Preferences: The two post-movie questionnaires asked about the ease of use and enjoyment of the experience with the software. A final questionnaire asked campers to rate and compare the two programs in terms of overall preference and in terms of specific moviemaking activities.

RESULTS AND DISCUSSION

This section begins with case studies of the production of two of the movies. We then present some of our findings organized in six categories — accomplishments, movie quality and experience, process and product, use of MAD, counselor effects, and success determinants.

Case Studies

Two movies will give readers a sense of the variety of camper experiences.

No Name: This first movie was rated last among the 16 films, receiving an overall score of 3. The group started by talking about themselves while writing a MAD script in point form. The script had a total of 37 words compared to the average of 171. It included no shooting instructions and no dialogue or narration. When they were ready to start filming the campers were still unclear what the movie was about.

"So, what's the story of the movie? … You mean we're just going to stand there and talk about ourselves?"

The movie is composed of a series of monologues, each one filmed with just one take without prior discussion or rehearsal. The group quickly moved to the next stage without reflecting on the quality of the product and taking the time to improve it. The results were poor choice of location, where noise levels led to inaudible monotones; poor camera location resulting in almost invisible speakers; long-winded monologues; and poor editing. The movie took 7.5 hours to complete, which was average.

QUEST: This was the highest rated movie, with an overall score of 15. The story deals with kids being sucked into a video game. The idea and most of the details originated with one camper who had some previous movie-making experience. The group started with a very detailed MAD script (283 words) outlining their intricate plot and dialogue. Both live action and video games were used, as well as smooth creative transitions in which game characters fade in and out of reality. The sound combined motion picture soundtracks such as the *Mission Impossible* theme imported off the Net, computer game sounds, and audio recordings input via the camcorder or directly into the computer. This 4.3 minute film contains 41 shots (camp average was 15 shots per movie) and took about 10 hours to complete.

Accomplishments

The majority of the campers had never made a movie before and had little computer experience. After a short time and with modest support they were able to produce creative and interesting films that they were very proud to show. Very quickly they learned about scripts, storyboards, locations, sound, camera angles, directing, getting video off the Internet, and editing digital movies.

Their first projects, "A Movie About Us," varied greatly. At the one extreme is *No Name*, discussed above [Case Studies]. At the other extreme, *Compilation* is a story about an invented character, a combination of the groups' identities, shown in a variety of settings and interactions, including both music and graphics.

The freedom to choose the topic for their second project stimulated them to create very interesting movies. These included a music-video-count-down show, and a variety of fiction thrillers about man-haunting monsters, robots taking over the earth, and kids getting sucked into video games (*Quest*).

Creativity: Independent of the technology used, the campers showed great creativity in their projects. They brought props and costumes from home. They drew maps and figures. Although the software provided did not support any special effects such as wipes or dissolves, the campers' movies included special visual effects such as an earthquake, many kids coming out of one locker, and people disappearing off the screen. Their movie titles vary from spoken on camera, to filmed chalk drawing on the board, to typeset text that is video recorded, and even to scrolling hand drawn titles set to music.

One group of students were initially very shy and hesitant to open up and talk. *Silent Movie* shows them sitting in a circle with voice-overs of their thoughts. The closing credits were precisely orchestrated with one camper panning the camera over the written text suspended on the wall, another camper looking at the clock and tapping the camera operator on the shoulder to indicate the panning speed, while the third camper controlled the music playback.

Working in a Group: There are many roles to be filled simultaneously in moviemaking, such as directing, acting, and camera work. Group work allows individuals with different ideas, talents, expertise, and preferences to work together and share the load. Campers enjoyed working in groups despite the occasional difference of opinion that had to be overcome.

Individual Preferences: Campers preferred a variety of activities including working behind the camera, being in front of the camera, seeing themselves on the screen, surfing the Internet, editing, and making special effects.

Camper 1: "I liked everything, but my favorite was editing on the computer."

Camper 2: "It was easy to edit. I thought it would be hard, but it's really easy. I like editing and filming, behind the camera."

Individual dislikes mostly related to waiting for the computer to digitize, compress, or download files. In addition, some campers were shy and uncomfortable in front of the camera.

Learning to Use the Technology: The campers quickly achieved competence in many different and new technologies — Macintosh computers, video cameras, digital editing, digitizing, and specific software.

Instructor: "How was it using that software?"

Camper: "It was the first time for me, I found it pretty good."

Instructor: "Easy, hard?"

Camper: "Kinda hard, but then you catch on and it's easy."

Learning Organization Techniques: Organization skills are extremely important in moviemaking. Some groups improved significantly over time. For example, on *No Name* the creators spent minimal time scripting and planning, filmed without rehearsal and without retakes, edited quickly and then moved on to the next part of the movie with no critical reflection.

They were much more professional on their second movie, *Wizard's Wrath*. They spent much time discussing the plot and resolving the details of their story. Point-form notes were expanded into a list of scenes and then into a storyboard depicting 10 scenes. Although the dialogue was not written on paper, the participants improvised and rehearsed their lines, and recorded numerous takes of each scene. They recognized the payoffs from this improved work organization — planning story details, creating a storyboard, filming ordered by location, digitizing in related segments, and editing in one stretch:

Camper 3: "The second one (movie) seemed easier to do.… The first one we didn't organize it…"

Camper 4: "Acting we did together, then we edited. We did it different from last time when we did a little bit of acting and a little bit of editing. This time we did all the acting together. I like it better with all the acting first because it is easier. …"

No Name scored 12 points out of 45, while *Wizard's Wrath* scored 32 (ranking fourth of 16). This undoubtedly was due not only to better organization but also to experience, the counselor, and the freedom to choose the topic.

Learning Moviemaking Techniques: The lecture about moviemaking was given following the completion of the first movie, when we thought the groups could benefit most from this discussion. Consequently, some of the mistakes in their first movies were corrected in the second films. Groups made conscious decisions concerning many details such as sound quality, camera work, and editing. While working on the first movie the following conversation took place:

Counselor: "We have a problem with sound. … We can improve the sound with MAD. … Hey, Dan, what do you think about the sound? Do we have to do it again?"

Camper: Shakes his head, NO!

Counselor: "OK, but next time use a microphone."

While working on the second movie, one counselor was overheard saying, "What motivated your choice of shots and panning?", demonstrating an increased awareness and focus on film quality.

Movie Quality and Experience

Movie quality scores [Table 1] were analyzed relative to experience information (first compared to second movies) which will be discussed in this section, and relative to process, counselor, and software effects, which will be addressed below.

		N	Quality			Script	Process			
Averages		Films	Creat	Tech	Overa	Length	Idea	Film	Edit	Total
TOTAL		16	9.4	7.9	8.1	171	66	107	151	325
MOVIE 1		8	7.9	6.3	6.3	172	50	89	152	287
MOVIE 2		8	10.9	9.6	9.9	169	83	132	150	364
MAD		8	9.2	7.7	7.8	177	68	100	192	359
OTHER		8	9.6	8.3	8.4	166	64	119	111	293
Movie 1	MAD	4	6.8	5.0	4.8	128	34	90	195	319
Movie 2	Other	4	10.3	9.0	9.0	114	64	154	113	330
Movie 1	Other	4	9.0	7.5	7.8	217	64	83	109	255
Movie 2	MAD	4	11.5	10.3	10.8	225	101	109	188	398

Table 1: Key quantitative results summarizing data about film quality, script length, and filmmaking process. The quality scores are out of a total of 15. Script length is measured in words. Process time is measured in minutes. All values are averages over 16, 8, or 4 films.

The effect of experience was seen during the camp with groups' second movies being rated higher than their first. An analysis of variance was performed to assess the effects of movie (first and second) on the quality scores (creative, technical and overall). A significant main effect of movie was found for overall score ($\underline{F} = 7.15$, df = 1, 15; $p < .05$) with the second movie (X = 9.9, sd = 2.9) being rated higher than the first movie (X = 6.3, sd = 2.7). As expected, the creative score for the second movie (X = 10.9, sd = 3.36) was higher than for the first (X = 7.9, sd = 2.10), although the difference just failed to reach significance (Movie 1 = 7.9, Movie 2 = 10.9; $\underline{F} = 4.48$, df = 1, 15; $p <= .056$). The increase in creative score is likely due in part to learning and to the fact that the children had total choice of the topic of the film. With more experience the technical scores on the second movie (X = 9.6, sd = 2.56) were also significantly higher than the first movie (X = 6.3, sd = 2.38) ($\underline{F} = 7.84$, df = 1, 15; $p < .05$).

There was a trend for groups which had at least one member with prior movie-making experience to produce movies of higher quality (28.1 total score) than groups without prior experience (22.8 total score), but this difference was not significant $t(14) = 1.19$, $p = 0.25$.

Moviemaking Process

In our analysis of filmmaking process, we distinguished, the amount of time spent on pre-production (i.e., brainstorming and script writing), production (i.e., filming), and post-production (i.e., editing). Analysis of variance tests were performed to determine the effects of movie (first versus second) and software (MAD versus Control, discussed below [Software Effects]) on the moviemaking process.

Movie 1 vs Movie 2: Analysis of the process information indicates that more time was spent in pre-production (i.e., brainstorming and script writing) for the second movie (X = 82.5 min., sd = 40.5) than the first movie (X = 49.5 min, sd = 22.5), (F = 5.2, df = 1,15; $p < .05$). (See [Table 1] for a summary of the process data). Also, in the second movie the groups spent more total time working on their movies (Movie 1 = 287 min, sd = 56.9, Movie 2 = 364, sd = 64.5), (F = 9.9, df = 1, 15; $p < .05$).

Movie Structure: An analysis of variance showed that significantly more shots or segments were recorded for the second movie (X = 24, sd = 7.9) than the first (X = 14, sd = 6.31) ($\underline{F} = 6.29$, df = 1, 15; $p<.05$). There seems to be a difference in the process between the two movies; even though significantly more video is recorded, there is no significant difference between final movie lengths or number of cuts between the two movies. The novice filmmakers learned to record more takes and to discard the unwanted ones prior to digitizing.

There are additional factors that could be contributing to the process differences between the first and second movies. Having the experience of making a movie did affect the way in which campers approached the task. New counselors affected the groups' work process. Choosing their own topic required additional time to develop a movie idea.

Software Effects

As in our previous research [Baecker et al. 96], the camp showed that MAD is a useful and usable tool for the creation of movies by novice filmmakers.

Movie Quality and MAD: An analysis of variance was performed for each quality variable to assess the effects of software (MAD versus Other). No effect of software was found.

Structure of Script in MAD: The script is an integral part of professional moviemaking. Our experience with amateurs highlights its importance in moviemaking and in MAD. The script is the backbone of MAD movies. All groups used *scripts*, although with greatly varying levels of sophistication. For example, in *Identity* the group wrote out all the lines that were spoken, whereas in *No Name* the group just wrote down a list of topics and improvised the narrative during the filming.

We were encouraged by some of the results showing that effort expended on the script pays off in terms of greater movie quality. The length of script was significantly correlated with two quality scores Creative (r^2=.47, p<=.01) and Overall (r^2=.33, p<=.05).

MAD provides a hierarchical structure and itemizes the script by scenes. This type of organization is not obvious to novices. Some campers described that they liked the segmented structure of their MAD scripts (as opposed to the undifferentiated flow of text in the control condition) and that they could easily change the order of the segments. After digitizing their videos they added video clips into their scripts and continued gradually building their movies in MAD.

Moviemaking Process and MAD: We wanted to see if the moviemaking process was affected by the software condition. It was hypothesized that the MAD groups could work faster on their movies because of the ease with which the software integrates movie components, but that this would also enable them to do more. We found that the MAD groups spent more total time working on their movies (X = 358, sd = 61.3) compared to their counterparts in the control condition (X = 293, sd = 67.6) (F = 5.98, df = 1, 15; p < .05). An analysis of the total editing time indicates that MAD groups did spend more time editing (X = 191.3, sd = 71.8) than their counterparts (X = 110.6, sd = 55.5) (F = 7.67, df = 1, 15; p<.05).

There are two factors that may have contributed to these results. Because of the greater technical and conceptual complexity of MAD, and because it is a research prototype and not a product, there were more human errors and technical problems than with the control software. Second, MAD's improved visibility and manipulation capability provided more opportunities for creativity, allowing groups to do more with their movies — easily incorporating numerous segments and additional editing of existing material.

There is some evidence for the latter explanation. For example, MAD allows the sound components of each movie segment to be created and manipulated individually apart from the video components; however, in the control condition sound must be finalized at the time of digitizing. In post-movie discussions, the campers in the control condition told us that they were hesitant to fix sound problems because it was "not worth it."

Software Preference: When asked which software they preferred for doing a variety of filmmaking activities, 91% of the campers expressed an overall preference for MAD, 0% for the control software, and 9% had no preference. Given a choice of software, the campers would prefer to take MAD home:

Instructor: "If you had a choice, which one would you take home?"
Camper 5: "MAD."
Camper 6: "MAD, because it's better, just better."
Camper 5: "MAD has more options."
Camper 7: "You can do more things in MAD."

The counselors and technical staff, who bore the brunt of the greater technical problems with MAD, were more divided in their opinions. Nonetheless, four out of six preferred MAD.

Counselor Effects

Counselors were UTS students chosen for their leadership abilities. None of the counselors had any moviemaking experience prior to the camp.

The counselors were instructed to assist the campers in their moviemaking; they were to facilitate discussions and aid with hardware and software but they were to let the campers guide the moviemaking process and mold the product. Nonetheless, the counselors ended up working very closely with the groups, contributing ideas and leadership to the process.

Counselor Contributions: The amount of counselor contributions varied greatly among counselors and with each group and movie. One counselor who took to the extreme our instructions to facilitate but not contribute directly provided no critical feedback and little guidance to the groups' stories and process. "Do you want to film more stuff now or do you want to digitize?" he would ask, exhibiting a lack of planning, which resulted in work processes that were unfocused and disorganized. His movies included *No Name* and were rated lower than others (averaging 19 versus a 25 average for all movies). Another counselor was much more involved in the groups' movies, providing ideas, assigning roles, directing process and filming, working the camera, directing the actors. While filming *Identity*, the counselor starts out directing the campers,

> Counselor: "Now we'll drop the game and he comes up and says, 'What do you mean you like McDonald's? ' … Oh, I forgot, you're supposed to be filming each other. … Let's do it all over again."

But the same counselor's behaviour differed with each group. We observed during the work on *Quest* that he was willing to be less directive when campers showed more initiative — "We can tape (film) all our taping in two hours and after lunch we can start editing."

Movie Quality: Counselors had significant effects on their groups' performance. For example, the counselor who worked on *Quest*, the highest rated movie (15 overall), also worked on the second highest rated movie *Phantom* (overall 13 out of 15). As we suspected, the overall movie scores were significantly related to counselors ($\underline{F} = 4.7$, df = 3, 15; $p < .05$), as were the technical scores ($\underline{F} = 3.8$, df = 3, 15; $p < .05$).

Instruction Methods: Each counselor employed a slightly different approach. Sometimes counselors gave very detailed instructions, talking the campers through minute interactions and manipulations of the software:

> "Press shift, drag the button, go back, let go … get rid of this and this too … fast forward to …"

At other times, counselors took more active roles in the process, doing more themselves, and thus reducing the campers' exposure and experience with the technology. In one incident a camper was asked to play a movie on the computer. While the camper hesitated, the counselor stepped in and took over the computer. These varied instructions led to different levels of understanding, comfort and competence among the campers.

Feedback Approaches: Counselors used different types of feedback with their groups. One counselor provided excessively positive feedback even when it was unjustified:

> "That's great! It's really good. (said following a single take)… We're done our intro."

This led to lower ranking films, such as *No Name*. Another counselor provided light-hearted but constructively critical feedback which led to higher ranking films, such as Wizard's *Wrath*:

> Camper: "So how does it start? … Laser beam?"
> Counselor: "Careful about the high-tech effects."
> Camper: "I get shot?"
> Counselor: "Do you have any ideas where you don't get shot?" (Do you have any ideas that are less violent?)

Clearly feedback influences movie quality, supporting the importance of feedback during moviemaking [Reilly 96].

Prior Experience and Attitude: The counselors' prior experience and attitude influenced their groups. One counselor working on *Compilation* suggested "Let's do a Storyboard; it really helped last time." In contrast, the counselor working on *No Name* felt the storyboard was "redundant in MAD," and expressed, rather negatively:

> "We're going to start making the movie. Its going to be a bit tedious … filming, then editing on the computer."

On the other hand, the counselor for *QUEST* explained in his introduction to MAD:

> "We're going to be using different software. … Its much better. You can do lots more with it, like include Internet pictures and soundtracks."

Determinants of Success

We looked at the most successful films to see if there were common elements among these movies and among the work processes followed by the groups. Five out of sixteen films scored more than 30 points (out of 45). One was a first movie: *Compilation*. Two were made using MAD: *Quest* and *Phantom*. Three used the control software: *Compilation, Wizard,* and *N-Bob.*

Process and Product Correlations: One thing these films have in common is that their idea phase, including brainstorming and script writing, lasted significantly longer (1.7 hours) than that of other movies (0.8 hours), $t(14)=3.65$, $p<.001$. In general the idea phase was significantly correlated with all the movie quality scores — Creative ($r^2=.69$, $p<=.01$), Technical ($r^2=.37$, $p<=.05$), and Overall ($r^2=.54$, $p<=.01$).

In other words, groups that spent more time working out their ideas and developing their scripts produced more interesting films and groups that viewed their movies critically tended to create technically superior films.

Script and Storyboards Improve Shared Understanding: All groups used scripts, although with greatly varying levels of sophistication. For example on Compilation the group wrote down all spoken lines (288 words) while on *No Name* they only wrote down the list of topics (37 words) and improvised their monologues during filming. The

length of script was significantly correlated with two quality scores Creative (r^2=.47, p<=.01) and Overall (r^2=.33, p<=.05).

Although there was no significant difference in movie length, the top five movies had significantly longer scripts (257 words compared to 134 words), t(14)=2.88, p<.05. And although there was no significant difference in number of scenes, these groups produced more detailed storyboards (4 scenes compared to 1.6 scenes).

Both scripts and storyboards are tools that the groups can use to transform vague ideas into concrete detailed representations of a movie. Without making the abstract concepts visible group members do not have a common representation of their movie concept. By making the concepts tangible and public they are able to discuss them in great detail and better evaluate their quality, prior to getting lost in low-level production details. For example, by using the storyboard as visualization tool for their movie, the group making *Wizard's Wrath* discovered that they had too many titles in their movie compared to the total number of scenes,

Camper: Looks at the storyboard. "We have way too many titles."

Counselor: "And too many people." (Too many different characters in the story, and appearing on the storyboard.)

They were able to deal with this early in the moviemaking, while changes are quick and painless.

Thus, through detailed evaluation and careful planning in pre-production, these groups reduced the need for extensive editing (editing time for top five movies X = 1.7 hours, sd = 0.76, other movies X = 2.8 hours, sd = 1.16). This difference just failed to reach significance (t(14)=2.04, p=.061) due to great variability in editing times.

Critical Reflection: Another similarity that was observed among the top five movies is the amount of critical reflection undertaken by these groups. The guest moviemaker suggested that everything in a movie must be done for a reason, every camera angle and motion, every scene change. These groups seemed to follow this advice, they spending much time discussing the details of their movies. Their films seemed better planned, thought out, and more intentional decisions were made than on some of the lower rated films.

SUMMARY AND CONCLUSIONS

Our multimedia camp was a success, a worthwhile and rewarding undertaking for 23 seventh graders. All groups successfully completed two movies; campers were proud of their movies and eager to take them home to show to family and friends. Many campers and their parents wanted to know if they could attend our camp again, next year. If this were possible, it would be interesting to see what they could accomplish one year later.

Yet we must temper our enthusiasm with the reality that multimedia camps are very hard to run. Equipment is still expensive and rare in local schools. Significant numbers of video cameras, computers and experienced support personnel are required for smooth function. Technical problems often lead to lost work and frustration with software and hardware.

Summary of Results

We have carried out a quantitative and qualitative analysis of data collected of the students' digital filmmaking activities. Our analysis has yielded the following results:

- Children can quickly become digital movie authors. This can be done with the assistance of relatively inexperienced filmmakers and some technical support.
- Children's filmmaking imagination and creativity is quite extraordinary, allowing them quick entry into the world of film authorship despite the lack of filmmaking theory, technical skills, or computer background.
- MAD has proved to be both useful and usable, confirming previous studies summarized in [Baecker et al. 96].
- With increased experience and exposure to filmmaking concepts, children's second films are more complex than their first films and are judged to be of significantly higher quality. Children do more editing and refining of their second films than their first films.
- Working with MAD seems to encourages more editing and refining than working with the control software.
- Children prefer MAD to the control software.
- There is a significant impact of counselors on both film quality and work process.
- Additional work done in the idea generation and script writing phase results in films of higher quality.
- Shared understanding, using scripts and storyboards, and critical evaluation during moviemaking leads to films of higher quality.

Unfortunately, some of our hypotheses proved not to be testable given constraints of the camp format and aspects of our experimental design. In particular, the projects were too short and the filmmakers were too inexperienced to conclude anything about speed of working with the two programs and about MAD's hypothesized ability to encourage and support filmmakers in trying more variations along the road to their final film.

Discussion and Implications

Given the lack of literature in this area, other thorough studies of moviemaking need to be done. In our next in-depth study of the use of digital filmmaking technology, we would like to change the task duration and the training and support given to the students.

As we have seen, the staff and counselors' background and expertise in filmmaking, hardware, and software had dramatic effect on the campers' experience. Small amounts of well-timed instruction in the lecture about filmmaking held after the children finished their first movie produced immediate effects, such as an improved variety of camera angles, better sound, and better editing. Although the fact that a relatively inexperienced staff can run such a camp successfully is encouraging in terms of the ability to replicate such as program widely, we are convinced that having a more experienced and better trained staff would have produced a richer learning experience for the campers. To paraphrase [Reilly 96], the teacher has the primary role in the classroom and technology has the secondary role.

More specifically, it was the case that without close guidance and highly structured instruction, children did not naturally follow the iterative design process and critical appraisal of their movies. We wanted students to go beyond the basic use of the tool to a more sophisticated discipline which involves the careful crafting of various media representations such as script or storyboard, which may involve collaborative work by multiple contributors bringing different skills to the endeavor, and which must involve thoughtful critiquing and iteration upon the result in order to produce the best possible product. This did not happen in our camp as much as we had hoped for.

Rather than trying to do this in a summer camp, it is more important to integrate collaborative multimedia authoring into the school curriculum as a vehicle for expanding students' creativity with projects and assignments in courses such as history and science. This should be done with close supervision and with continual and critical feedback from both teacher and classmates [Reilly 96].

If we can achieve this, we believe that tools such as MAD supported with reasonably straightforward learning materials can enable a powerful and compelling new classroom literacy for telling stories, exploring concepts, and expressing ideas.

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