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The Educational Potential of Multimedia Authoring as a Part of the Earth Science Curriculum—A Case Study

Nir Orion, Yaniv Dubowski, Jeff Dodick

Department of Science Teaching, Weizmann Institute of Science, Rehovot, Israel 76100

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Abstract: The purpose of this study was to assess the potential of multimedia authoring, as a learning tool, using the software ASTOUND. The subjects in this study were 32 students in two Grade 12 classes. The context of the study was a multi-disciplinary environmental unit about earthquakes. Students were provided with basic background about earthquakes via laboratory experiments and field trips. At a later stage, the students did in-depth independent projects on selected topics related to earthquakes. Once completed, the students presented their projects using the multimedia software ASTOUND. The research consisted of the following stages: a pre-development phase; curriculum design phase; implementation and evaluation. The research tools included: questionnaires, interviews, observations, concept mapping, and an analysis of the multimedia presentations. The findings showed that an integration of laboratory exercises, field trips, and an independent study project, could lead to meaningful learning. However, although most of the students enjoyed using the multimedia program, there was no evidence to support the assumption that it contributed to knowledge acquisition. In fact, much of the time invested in multimedia authoring was devoted to producing decorative effects, reducing the time available for meaningful learning. © 2000 John Wiley & Sons, Inc. J Res Sci Teach 37: 1121–1153, 2000

Introduction

This study focuses on the educational potential of the multimedia environment. It was conducted within the framework of developing a model for integrating environmental issues within the current Israeli high school earth science curriculum.

Orion (1995) suggests that one of the advantages of learning earth science is that it fosters greater environmental awareness. Indeed, most earth science educators agree that the earth sciences should be taught within an environmental framework (Carpenter, 1996; Mayer, 1995; Orion, 1997). This current work is an attempt to reduce the gap between the desire to teach environmental issues in the Israeli earth sciences curriculum, and its realization in Israeli schools. This was accomplished by adding environmental issues associated with earthquakes within the unit "The Dynamic Earth." This subject was chosen because of the large influence

Correspondence to: N. Orion

that earthquakes have on human life in Israel. The abundant evidence for seismic disturbances in Israel, both historical and geological, poses relevant questions about their social, economic, and political effects.

In the past, science teaching has emphasized the "instructional" paradigm, which focused on the role of teachers and curriculum developers in the educational process. Many studies published from the end of the 1970s until the present have shown the limitations of this approach and instead posit an alternative approach—"constructivism" (Bezzi, 1995; Driver, Guesne, & Tiberghien, 1985; Osborne & Wittrock, 1985).

In constructivism, the student is the focus of the educational process. This approach argues that information is subjectively learned and is built by the learner on the basis of his previous experience. Thus, in such a subjective process, the student must be stimulated toward independent learning that will be truly meaningful. This understanding has significant implications for the teacher whose role now changes from being the source of knowledge to being its mediator (von Glasersfeld, 1989).

The development of computers in the last decade has given educators a tool with great potential for stimulating students toward independent study. For example, Lehman (1995) argues that the use of the computer can cultivate the students' ability to solve problems, help them understand abstract scientific concepts, and permits them to simulate scientific phenomena. The use of illustrative tools such as animation, graphs, sound and video clips in one machine, makes it possible to show the student many phenomena which cannot be demonstrated using conventional teaching methods. The subject of multimedia as a didactic tool in general, and the building of presentations by students in particular, is in the forefront of curriculum development within the field of science teaching (Hay, Guzdial, Jackson, Boyle, & Soloway, 1994).

The definition of multimedia presentations is very broad. Much of the software described as multimedia, such as mapping programs, painting software and graphing packages, focuses on creating dynamic displays. This study, however, focuses on software packages, which are based upon connecting a series of slides into a coherent presentation. In each screen the designer combines various multimedia tools to illustrate the chosen subject.

A survey of the literature shows several studies, which have tried to characterize the constructivistic learning processes involved in student-built multimedia presentations. This survey illustrates a number of potential benefits accruing from this learning environment.

Thus, Lehman (1995) and Hay et al. (1994) claim that multimedia authoring is a powerful constructivist tool, since it enables students to cope with the material personally, actively learning at a pace which is suitable to them. In the same vein, Scardamalia, Bereiter, Iclean, Swallow, and Woodruff (1989) and Bransford, Sherwood, Hasselbrung, Kinzer, and Williams (1990) suggest that the process of building a presentation is a powerful tool for developing "ownership" over a particular subject, motivating the student to learn, and at the same time demonstrating understanding of the material being studied.

Moreover, Rielly (1992) and Pea (1991) note that presentation-building can be organized into a cooperative learning system, permitting students to actively work with their peers.

Finally, a number of studies (Greeno, 1989; Hay et al., 1994; Kozma 1991; Neuwirth & Kaufer, 1989) suggest that combining pictures from the field, videos of lab experiments, taped interviews with experts, and Internet sites encourages the student to combine different information sources and learning environments. Thus, in building the presentation, the student learns how to organize such information, as well as how to present it using a wide variety of tools.

The survey of the literature also reveals a number of difficulties associated with building multimedia presentations. Turner and Dipinto (1992) argue that, in order for the student to be a designer of multimedia presentations, he must not only learn the subject in question, but he must also learn how to effectively manipulate the software. This requires preparation time and close supervision of the students at the early stages of a project. In addition, technical problems often cause delays and frustration, such that they might overshadow the cognitive element of organizing the material. Finally, Clark and Salomon (1985) note that the excessive motivation shown by students toward multimedia-learning environments can distract them from the tasks at hand. All of these factors, both positive and negative, will be examined in this study.

Purpose and Research Questions

The objective of this study is to explore the educational potential of student-authored multimedia presentations. In this study the following questions were addressed:

1. Did the building of a multimedia presentation positively affect student knowledge and attitudes concerning the environmental effects of earthquakes?
2. Are student-authored multimedia presentations an effective tool for organizing information?
3. Are student-authored multimedia projects an effective tool for integrating knowledge acquired in different learning environments and from different subjects?
4. Which elements of the computerized learning environment reduce the potential for effective learning?
5. Can one characterize a typical learning pattern associated with building multimedia presentations?

The Design of the Study

In order to monitor the changes in student knowledge and attitudes prior to, during, and following the presentation building, this study was carried out in the following three stages:

1. Pre-development research. In this stage we explored student knowledge and attitudes on earthquakes, after they had completed this topic as part of the earth sciences curriculum.
2. Implementation, which consisted of the following:
   - Observing the students during the program.
   - Interviews.
   - An attitude questionnaire concerning elements of the program that the students had studied to this point.
3. Post-testing which consisted of the following:
   - Collecting data examined in the pre-development stage.
   - Analysis of students' presentations.
   - Interviewing teachers about the program.

Sample and Treatment. Two classes, from two schools, consisting of 32 Grade 12 students who were studying earth science for their matriculation examination took part in the study. The second author along with the earth science teacher taught the module on building multimedia presentations. This module directly followed the unit "The Dynamic Earth" which included a section on earthquakes taught by the earth science teacher.

The multimedia project consisted of the following three phases:

INTRODUCTORY PHASE

The students expanded their knowledge about earthquakes highlighting its scientific, social, and economic aspects. The following materials were used:

- An activity guide illustrating various aspects of earthquakes to the students using a broad range of learning environments—demonstrations, lab experiments, discussions, and video clips.
- Two field trips dealing with the geological and archaeological evidence for earthquakes in Israel.
- A database which includes articles, video clips, and computerized pictures (Dubowski, 1996).
- A guide book for building multimedia presentations.
- A multimedia presentation introducing earthquakes. Its purpose was to provide an example of a multimedia presentation using the software ASTOUND, as well as to serve as an introductory lesson about earthquakes. The subjects in this demonstration included: the physical causes of earthquakes; earthquake localities; earthquake damage; earthquakes in Israel; predicting earthquakes; and the environmental effects of earthquakes.

INDEPENDENT STUDY PHASE

Each class was divided into groups of 2–4 students which then:

- Chose a topic and formulated research questions (with the approval of the teacher). Three possible topics were presented (earthquakes in Israel—past, present, and future; from wave to devastation—the effect of tsunamis; the interaction between man and earthquakes). There was also an option for the students to choose their own topic.
- Located possible sources of information, raised hypotheses concerning the research questions, divided the labor, and built a work plan.
- Submitted the results of the research in a typed report.

The primary research source was a database that was specifically prepared for this task. It included 30 articles, 10 video and news clips, seismic and dispersion maps of earthquakes, and a simulation program that dealt with earthquakes. A secondary source of information was a list of academic experts whom the students could contact.

The project was an independent activity in which the teacher's function was to mediate between the students and the sources of information. In order to give the students freedom of movement while supervising this activity, guidance sessions were held during the research stage. Concurrently, the students were required to maintain the timetable agreed upon at the beginning of this phase.

PRESENTATION BUILDING

The students organized the information they had gathered in the previous stage so that they could build their presentations.

There are a large number of programs for building multimedia presentations with a wide range of price and performance. The software ASTOUND was selected for the current study following a preliminary study (conducted in 1995) which examined six different PC-oriented programs: ACTIVE2, POWER POINT, ASTOUND, COMPEL, KNOW2, and TOOLBOOK. What made ASTOUND unique (at that time) was its ability to coordinate different objects within a slide, giving the designer greater freedom in building different types of animation.

Windows compatible, ASTOUND belongs to the family of multimedia authoring software which focuses on the visual presentation of information. An ASTOUND presentation is built in the form of dynamic slides in which the objects (picture and text) are controlled by the designer. After combining the desired objects, one can synchronize their appearance within the slides by adding "movement" (such as entry or exit points). Such synchronization makes it possible to create simple animation sequences, which better illustrate complex topics. A more detailed description of this software is found in the Appendix.

The building of student-designed presentations is a new learning technique. In order to minimize its novelty, an introductory lesson was held with the software. Also, an instruction manual on building multimedia presentations was written for the students (see Appendix).

One of the most useful tools of multimedia programs is the integration of pictures into the presentation. To help the students find pictures, a searchable file was built consisting of 170 pictures from a variety of fields related to earthquakes.

THE PRESENTATION PHASE

During the final stage, the students gave their presentations to the entire class and several visitors including earth science researchers, the inspector of earth science education, the head master, and other teachers. In order to increase student motivation they were informed about this event before beginning the independent study phase.

It is important to note that prior to beginning the projects the students were told that in total, the self-study and the ASTOUND presentation would count for 20% of their final matriculation grade.

Subjects.

CLASS 1

Class 1 consisted of twelve Grade 12 students from a kibbutz school located in the southern part of the rift valley near the city of Eilat. The classroom teacher defined the level of motivation amongst the students as average, and noted that absenteeism was very widespread among his class. The program was a mandatory part of their earth science curriculum. Several students with little computer experience protested the use of computers as an obligatory part of the program.

The project began in November 1995 with a fieldtrip to Eilat to survey the damage caused by a recent earthquake. In the beginning of January 1996, the second author met with the students, explained the structure of the project, and presented the demo presentation. After this lesson, the classroom teacher taught the introductory lessons himself, during 6 hrs of instruction in which he presented only two-thirds of the lab activities, which had been developed for this stage.

The independent study phase lasted 2 weeks and was carried out by groups of two or three students. Each group selected its own topic for independent investigation. The teacher's reports show that none of the groups handed in their report on schedule. After an extension was granted, the groups handed in a short, superficial synopsis of their findings.

Presentation building began at the end of January 1996 and was taught by the second author together with the teacher in three concentrated days of activity (18 hrs total time) in the school's computer classroom. Each group had the use of a 486 computer with a sound card.

During the presentation building phase, it was discovered that the schools network was not sufficient for a project of this type. The system worked very slowly and computer "crashing" was common. This caused the students great frustration, especially when they lost part of their work. Presentation building literally continued until the last minutes before the projects were shown to the entire class. Two weeks after finishing their project, three of the groups sent their presentations to the second author after altering (in their own free time and without receiving extra credit) those elements that they had not completed during the project-building phase.

CLASS 2

The 20 students in Class 2 attended a traditional urban high school. According to their teacher, the students were good, although not easily disciplined and absenteeism was widespread. Several students had no experience with computers and protested their compulsory use. They even asked for an exemption from building the presentations, preferring instead to hand in their projects in written form. Their request was denied.

Following the implementation of the program in Class 1, it was decided to make a number of changes in the implementation with Class 2. All of the activities in the lab booklet were taught; moreover, two fieldtrips were developed as a part of the introductory unit. A planning tool was designed in order to help the students plan their independent study in terms of defining their research questions, the scope of their projects, and environmental aspects of their study. The students were also requested to prepare a short progress report every week. The manual on multimedia presentation building was improved and the students were required to prepare a flowchart of their intended projects. Presentation building itself was extended to 40 hrs.

The introductory unit was begun in January 1996 and included 12 sessions and two full-day fieldtrips. The independent study phase began in March with each group selecting its own topic for the independent investigation. The teacher monitored the independent study of the groups and helped them to obtain the necessary resources for this work. Three of the groups worked quite intensively. They even interviewed academic experts concerning aspects of earthquakes which they did not understand from the prepared database.

The presentation-building phase began in May, after it had been postponed several times because of missed deadlines. This phase lasted 3 weeks (40 hrs) and was taught by the second author. Each session lasted from 4 to 6 hrs and were held two to three times a week. The students arrived at this phase with computer-typed papers but with no scanned pictures.

Toward the end of the presentation-building phase, the students continued to work independently for another 15 hrs. There were many technical problems due to a lack of suitable computers and a shortage of memory. As with Class 1, preparation continued until the last moments before the final screening. During the final screening, which lasted 4 hrs, the groups presented their research topics before the class and special guests from the Ministry of Education. As the multimedia presentation counted for 20% of the students' matriculation score in geology, the students took this work seriously and invested considerable effort.

Methods and Research Tools

To address the research questions, tools specifically developed for the present study, as well as tools adapted from previous research were used. These included quantitative tools which evaluated the results obtained from the research population, and qualitative tools which validated the quantitative research tools, as well as contributed to a better understanding of the students' learning process.

The following research tools were used:

1. *A Likert-type (knowledge) questionnaire which probed familiarity with concepts.*
   In this questionnaire, the students were asked to define their level of familiarity with 15 concepts related to earthquakes. Four levels of "familiarity" were defined: 1. Don't recognize at all 2. Recognize but don't understand; 3. Recognize and understand; 4. Recognize well enough to explain to a friend. The authors chose this type of questionnaire rather than a questionnaire which tests knowledge directly, as Arzi, Ben-Zvi, and Ganiel (1986) have demonstrated that students' answers to these types of

questions reflect their level of knowledge without forcing them to provide an open-ended definition of the concept. This questionnaire was distributed to the students both before and after completing the curriculum.

2. *Open (knowledge) questionnaire.*
   This questionnaire, distributed both before and after the program, queried the students' awareness and attitudes toward environmental issues in general as well as toward those issues that specifically affect the State of Israel. An example of such a question is: *What, in your opinion, are the most important environmental challenges that Israel faces today?*
3. *A multiple-choice questionnaire.*
   The purpose of this questionnaire was to ascertain whether students learned and understood the concept of earthquake propagation. In addition, it monitored the reliability of the answers received in the Likert-type (knowledge) questionnaire mentioned in part 1 above.
4. *A semantic differential questionnaire on qttitudes toward the learning program.*
   The semantic differential method was developed by Osgood, Suci, and Tannenbaum (1975) and has since been used in many studies. The present questionnaire is composed of 16 word pairs, with a scale of seven categories separating each word pair. The 16 word pairs are divided along three conventional dimensions: practical, emotional, and cognitive. This questionnaire measured the initial attitudes of students regarding the study unit on earthquakes, and the changes that took place in these attitudes following the learning of the program.
5. *Likert-type attitude questionnaire.*
   This questionnaire was developed for this study and consists of 24 statements to which the students were asked to state their agreement on a scale of 1–5 (strongly agree, agree, not sure, don't agree, and don't agree at all). The statements reflect attitudes toward three areas: earthquakes, computer-aided learning, and group work. Three science education experts validated the content and structure of the statements.
6. *Concept maps.*
   Use of concept maps to determine knowledge structure is quite widespread (Ruiz-Primo & Shavelson, 1996). In order to better represent the knowledge structure of the student on the subject of earthquakes, the authors used the 'Network' technique (Shavelson, 1974).

This tool was applied in two stages, similar to the method of Barenholz and Tamir (1992). In the first stage, the students were asked to prepare a list of concepts they believed were related to the topic in question. In the second stage, they were asked to arrange the concepts on a network map, connecting the concepts, which they thought were interrelated by drawing arrows between them. By analyzing the content of the concepts and the connections the students drew, it was possible to obtain a qualitative answer about the students' knowledge structure. Concept maps allowed the authors to determine the extent of knowledge and the contexts the student creates between various concepts, since in the process of drawing arrows, the student must organize the information he possesses in a hierarchical and organized fashion (Ruiz-Primo & Shavelson, 1996).

The concept maps were analyzed in two stages. In the first stage, they were evaluated by both determining the appropriateness of the concepts to the specific topic, as well as by checking whether each of the connections between concepts made sense in relation to the subject. Five experts including earth science teachers, curriculum developers, and academic researchers analyzed the resultant maps independently.

Following this stage, each concept map was analyzed in two ways:

1. According to the number of appropriate concepts that appeared on the map. This measure made it is possible to quantify the level of knowledge.
2. According to the number of concepts which are appropriately connected to two or more concepts (more than one entry and exit arrow). This is a qualitative measure of the level of connections made by the student.

The second analysis was conducted by the second author and was validated by five content experts. Both the number of concepts as well as connections were evaluated on a two-level scale indicating whether they were appropriate (or not) to the concept map.

Comparison of the concept maps drawn both before and after the program permitted the authors to measure the changes in the students' understanding quantitatively. This measure was applied to two areas: (a) representing the student's knowledge of earthquakes, both before and after learning the program and (b) identifying the quality and quantity of the most associative knowledge that the student has on the subject of earthquakes.

The students received a limited amount of time to prepare their concept maps. Thus, such maps actually represented only the most immediate concepts related to the selected topic, and not the connections and concepts the students actually possessed on this subject.

7. *Interviews:*
   Interviews were conducted before, after, and during the course of the study. The following are the interview techniques used and the variables measured:
   - Taped personal interviews were conducted with a sample of four students (two from each class) during which they gave answers to questions that appeared in the attitude and knowledge questionnaires. The purpose of the interviews was both to validate the questionnaires as well as to understand the student's attitudes in greater depth. The questions in the interview were prepared in advance. After answering, the students were asked to elaborate.
   - Taped group interviews were conducted during the presentation building. Their objective was to identify difficulties associated with the project, as well as to characterize the students' learning process during presentation building.
   - Summary discussions were videotaped in the class in order to receive feedback from the students about the presentation-building process. The students were asked to express their opinions about the program and its learning methods. This discussion permitted the students to express their opinions and helped the researchers to define the mood of the students following the program's implementation.
   - The classroom teacher was interviewed at the conclusion of the program about the educational materials and learning strategies. This interview was crucial for obtaining feedback that would help the researchers complete the formative evaluation of the program.
8. *Designing a presentation flowchart.*
   This tool was only employed with the second class. In the first stage of presentation-building, the students were requested to construct a hierarchical flowchart, which would organize the material they had gathered during their independent study. Using the flowchart the first outline of the presentation was built.

   By comparing the flowchart built at the first stage of presentation-building with the final presentations themselves, the researchers were able to plot the changes, which the students underwent during the design process. Because of its similarity with the concept maps, the researchers decided to compare the flowchart with the final presentation at two levels: technical and structural. "Technical level" refers to the differences between the topics presented in the flowchart with the topics included in the final presentation. "Structural level" refers to the following parameters:

- Number of relevant slides in the final presentation as compared with the number of cells in the flowchart.
- Number of relevant branches in the presentation as compared with the number of branches in the flowchart.
- This analysis was conducted by the second author and was validated by five content experts.

9. *Observations conducted during the presentation building.*
In order to characterize the learning process during the presentation-building phase, group work was observed by an external critic. Each group was monitored at least twice during each session for 5–10 min each (the sessions lasted 4–6 study hrs). An observation sheet was developed for this study; it included the following seven criteria (Table 1):
   - Dealing with content. Recording the students' work-related discussions permitted the authors to analyze the amount of time invested by the students in the material.
   - Technical level. The observer classified the technical levels of the students' work during presentation building: basic or complex. Basic technical work included activities such as importing text into the presentation, integrating pictures, and adding graphic format. Complex technical work included activities that required a higher command of the computer-aided design process such as synchronizing objects, scanning pictures, and sound recording.
   - Design work. This included the amount of time the students were engaged in designing the presentation. From these observations, one can compare the amount of time invested in working on subject matter with the time invested in designing the presentation. However, since time spent with the subject material may also be spent in designing an explanation of a certain concept, two kinds of design were defined: decorative and explanatory.
   - Decorative design does not contribute to an understanding of the subject being studied. It includes integrating animation with no connection to the subject, the selection of a colored background, and selection of sounds, which do not contribute to the presentation.

Table 1
Example of a completed observation sheet

			Technical work		Design work				
Group name	Date Hour	Work on subject	Basicl technical	Complex technical	Decorative design	Explanatory design	Team work	Emotional dimension	Comments and key statements
Yoram, Shai	21.1.96 12:00	Typing text	Captioning text				Yoram dictates and Shai writes	Expression of impatience	"Ooph, until this thing gets moving... (the computer)
Ran Yuval	21/1/96 12:30			Synchronizing animation	Adding simple animation		Ran eats, Yuval works	Enthusiasm	"Ran, look how cool.."
Omer, Samar	21/1/96 13:00	Text narration		Recording sound		Narration describes the picture	Both work	Engrossed in their work	

- Explanatory design is concerned with features, which contribute to an understanding of the material. For example, integrating text and pictures, which are connected to each other; illustrating an idea using pictures, and using video or animation for illustrating important issues.
- Group work—In order to examine the effect of the new learning environment on group work, the role of each group member was recorded. These data made it possible for the researchers to draw conclusions about desirable working methods for such projects.
- The emotional dimension. The mood of the students was evaluated so that both the "emotional" advantages and disadvantages of this new learning tool might be identified.

10. *Analysis of presentations.*

    The presentations designed by the students are the final product of the learning process and therefore, the researchers analyzed them carefully. To date, there have been few studies analyzing multimedia projects. The most recent and complete research by Hay et al. (1994) evaluates presentation-building based on the following criteria:
    - The scope of the content material in the presentation. This is defined as the number of words in the presentation.
    - Level of proficiency in designing the presentation.

For this study, additional criteria were added to those mentioned by Hay et. al. (1994). They include:

- The content: Hay et al. (1994), using the MEDIA TEXT program, analyzed the content characteristics by counting the number of words in the presentation. ASTOUND does not have this capability, therefore we analyzed the content based on the criteria established by Orion (1994) for evaluating a "Geotop" project.

  Scope of project (40%)—A sufficiently broad subject, complexity of research, degree of effort invested in preparing the project, Quality of work (60%)—Clarity of objectives, (i.e., clear and logical connection between objectives of the project, findings, and conclusions). Use of proper terminology, distinction between major and secondary issues, accuracy of facts and figures, presentation of the data using the appropriate means, a broad perspective concerning the subject, an appropriate discussion of the results and drawing logical conclusions.
- Design features: This analysis was based on two levels of design:

  "Decorative design"—design which has no importance in explaining the subject matter and whose purpose is purely decorative. Removal of such elements will not detract from the subject matter in the presentation. Such design is labeled "Annotated Text" (AT) by Hay et al., (1994).

  "Explanatory design"—Design intended to explain the subject matter. Design which uses metaphor and escalation (Greeno, 1989; Neuwirth & Kaufer, 1989). This feature makes it possible to obtain an understanding of the student's ability to transfer material that he has learned into the presentation and is evidence of the depth of his comprehension of the subject researched. Hay et al. (1994) term this "integrated composition" (IC) presentations based on more than one type of media to convey their subject matter.

Since ASTOUND makes no distinction between text and other types of media, the researchers did not use the "Annotated Text" and Integrated Composition" of Hay et. al. (1994) and instead defined several levels of design. Based on this definition, a scale was constructed so that the researchers could measure the level of thought and effort invested by the students in illustrating their topic. The following is a description of this scale.

1. Presentation of text only (text or narration).
2. Unconnected decoration: the addition of decorative elements which are unconnected to the subject matter (e.g., presenting the subject of earthquakes on a background picture of a hot air balloon).
3. Connected decoration: adding decorative elements, which are connected to the subject matter (e.g., presenting data about Eilat on a background picture of the city).
4. Connected design: connecting the elements of the presentation (pictures and text) (e.g., using arrows to direct attention to a picture; using a combination of narration and text).
5. Explanatory design: the use of metaphor and illustration; use of the media to explain the content; integration of video clips at the appropriate place; animation to explain a phenomenon.

This scale was a key tool in quantifying the levels of design used in the presentations. The final design grade was based on an average of the grades of all the slides. Analysis of the presentations was conducted by the authors and was validated by the previously noted content experts.

- Sources of information integrated into the presentations: A basic premise of this research was that building presentations would encourage the students to integrate different sources of information and different learning environments into their projects. In turn, a combination of such sources may lead the student toward a better understanding of the subject material. Tables 2 and 4 contain a section which lists the sources of information (types of media as well as learning environments) integrated into the presentations in both Classes 1 and 2.
- Evaluation of connections with the various fields of knowledge: Following Kozma (1991), we characterized an additional criterion: the number of fields of knowledge mentioned in the presentation. Tables 2 and 4 contain a section listing the connections that the presentations in Classes 1 and 2 made to different fields of science.
- Characterizing the presentation structure: By analyzing the presentation's structure, one can evaluate the scope of the material learned and presented. Two measures were used to characterize the structure of the presentation:
  1. Number of slides in each presentation: This permitted the researchers to evaluate the amount of effort invested as well as the scope of the material used in the presentation.
  2. Number of slides that have more than one entry or exit: This criterion measures the level of organization of knowledge. Comparing this measure to the pre-presentation flowchart enabled the researchers to evaluate the contribution made by the presentation on the students' knowledge.

Results and Discussion

Although the focus of this article is a learning strategy based on building multimedia presentations, it is better to discuss it within the broader context of the unit developed.

In view of the limited size of the test groups, we used the non-parametric Wilcoxon Matched Pair Test to compare the pre and post-test data.

Due to the changes in curriculum between the first and second implementations, the findings for each class will be presented separately.

Results of Class 1

The overall evaluation of the program.

The changes in the levels of knowledge and attitudes for the whole program were analyzed by comparing the pre- and post-test scores for the questionnaires, as well as through analysis of the concept maps.

A detailed description of this analysis and their findings can be found in Dubowski and Orion (2000). These findings indicate that the program significantly increased the students' level of knowledge. However, it appears that there was no meaningful internalization of the connection between earthquakes and their environmental and social impacts.

Feedback about the program was gathered from students' responses to open-ended questions included in the post-test questionnaires. Their answers indicated that in general, the students viewed the program as a positive experience. Eight of the nine students who answered the open ended questionnaires stated that they would recommend teaching the curriculum in its present format in the following year. The following are some typical answers:

"*It was interesting (better than the usual learning done in the classroom) but we didn't have enough time to build the presentations.*"

"*Definitely yes. The experience of presentation-building was fun on the whole and teaches the material in an interesting and helpful way.*"

"*Yes, since at the end, when we finish the presentation, the material is better understood and it's easier to explain.*"

Characterizing Presentation Building. Figure 1 shows the division of tasks during presentation building. It is based on an analysis of direct observations and video filming of

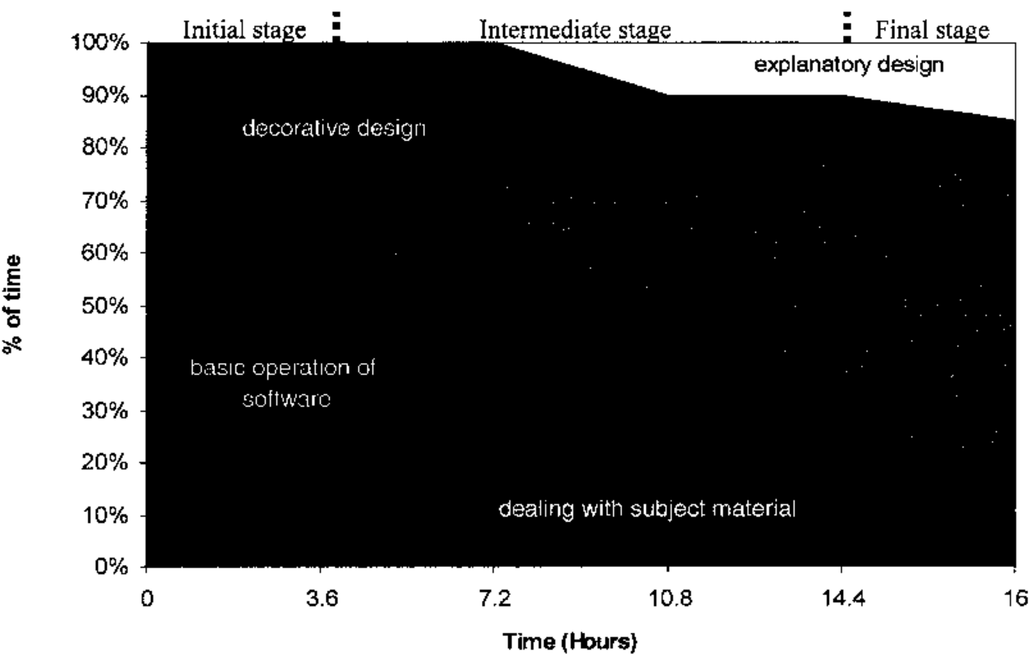


Figure 1. Distribution of activities during presentation-building (Class 1)

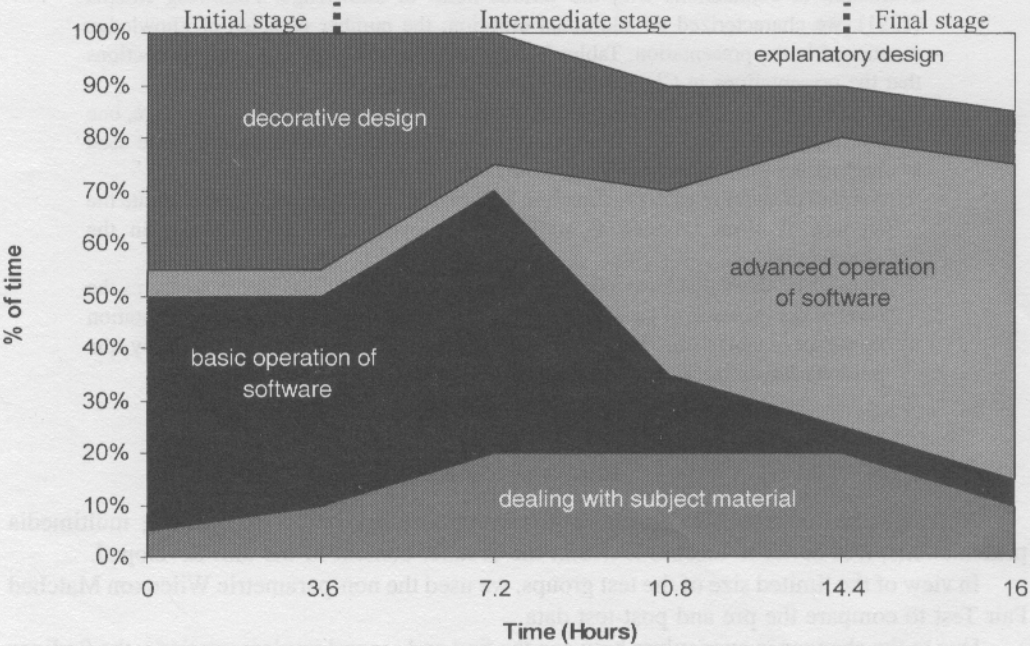


Figure 1. Distribution of activities during presentation-building (Class 1)

class activities (as noted in the Methods section). It shows that presentation building can be divided into three main stages:

1. An initial stage lasting approximately 4 hrs, most of which was devoted to basic technical issues and decorative design. At this stage, the students learned the capability of the software and dealt primarily with special effects such as changing the background color, adding sound and combining pictures.

2. An intermediate stage lasting approximately 10 hrs, in which the students began to deal with the subject material, but still devoted some 80% of their time to technical aspects. At this stage, the students progressed toward more complex technical elements such as: testing effects during slide transitions; controlling command capabilities; and synchronizing objects. With one group, explanatory design began appearing (albeit at the expense of decorative design).

3. A final stage lasting approximately 2 hrs, in which the students prepared the presentation for screening. In this stage, involvement with subject matter declined to a minimum, the majority of the effort being focused on complex technical aspects. The group, which had begun its explanatory design in the previous stage, slightly expanded the amount of time devoted to this aspect. However, none of the other groups delved into explanatory design. The final stage lasted 2 hrs due to constraints in the school's schedule. All the students claimed that they did not have sufficient time to complete the project. Three groups continued to work on their presentations even after the formal end of the program and sent the second author the updated versions. They reported that they had worked on the presentation for additional 10 hrs. However, a comparison of this work with the presentations viewed in the classroom, showed no change in the level of explanatory design.

After analyzing the student's work during presentation-building, two important findings emerged:

1. Only a very small part of the time (less than 20%) was devoted to the actual content of the project.
2. Only one group achieved mastery of explanatory design.

The Effect of Presentation Building on Knowledge Levels

One of the most important parameters examined in this study was the effect of presentation-building on the students' level and organization of knowledge. This parameter was tested by directly analyzing the presentations. The following are the results of this analysis (Table 2):

1. Content analysis: An analysis of the quality and scope of the presentations shows that the level of grades ranged around 50%, except for one project (group 2) which received 78%. This indicates that building the presentations did not profoundly change the students' knowledge of earthquakes.

2. Analysis of structure: A similar number of slides (from 13 to 20) existed in the various presentations. Each presentation had a simple structure, consisting of a menu, to which one entered and returned. Only one group had an additional sub-menu. The simplicity of the presentations matched their low content level.

3. Analysis of design. Four of the five groups achieved a level of design that did not exceed a grade of 2.5 (on a scale of 1–5), suggesting that most of the design was decorative. Only one group (group 5) achieved a high level of design. However, its content level was low. In contrast, the group with the lowest level of design (group 2) received the highest grade for content. In general, the students in Class 1 did not take advantage of the explanatory potential inherent in

ASTOUND. The results are evidence that the students did not understand the difference between a written paper and a multimedia presentation.

4. Integration of knowledge acquired from different learning environments. Integrating different sources of knowledge acquired from different learning environments is a major challenge to students' effective learning. The connection between information associated with the lab, textbook, or even class discussions is not as clear as one might think (Hofstein, Cohen, & Lazarowitz, 1996). In the case of Class 1, most of the groups gave few examples in their work of different learning environments or information sources. In three projects, taped interviews with experts were integrated into the presentations. However, most of the materials presented were those that were most accessible to the students: library books, class activities, and pictures from the computer database.

5. Integrating knowledge from various fields of science: The field of knowledge most frequently drawn upon was geology followed by environmental science and physics. In four of five presentations, the groups emphasized geology. As for environmental science and physics, terms from these fields also appeared in the presentations, but with little explanation. Only in one presentation (group 2: earthquake damage) was it possible to discern a meaningful connection between earthquakes and the environment. Group 5's presentation (earthquake damage) also dealt with the environment; however, the group ignored such aspects and concentrated solely on geological implications.

Table 2 indicates that for most students in Class 1, the presentation-building stage did not contribute significantly toward a meaningful integration of different learning environments and information sources. These findings contradict Hay et al. (1994) who claim that building multimedia presentations encourages the student to combine different learning environments. Also, they do not support Kozma (1991) who argues that building presentations facilitates an improvement in the student's metacognitive ability as a result of focusing on the connections between ideas, which encourage the transfer of knowledge from one field to another.

Attitudes Toward Multimedia Presentations

The changes, which took place in students' attitudes toward multimedia presentations as a learning tool, are presented in Table 3 and suggest the following:

1. Students came to the project with high expectations that multimedia is a tool, which contributes to greater understanding and motivates one's interest in learning. Concurrently they felt uneasy about the amount of time that the project would require.
2. At the end of the program, there was a significant improvement in the students' attitudes toward the role of multimedia in increasing their interest for learning about earthquakes.
3. Moreover, the expectation that the presentation would be a valuable tool for increasing knowledge was largely met.
4. Finally, the students' unease over the extra time required for multimedia projects was significantly replaced by the attitude that the extensive work invested in the project was well spent.

As noted before, most of the students at the post-test phase of the research focused their comments on presentation building. Some expressed dissatisfaction with the lack of time and technical problems that they encountered during their work with the computers. The following responses summarize these feelings:

Table 2
Analysis of the presentations (Class 1)

	Content				Design	Structure	
Presentation	Scope project (0–40)	Quality of work (0–60)	Connections to subject areas	Learning environments and sources	Grade (Scale = 1–5)	No. of slides	No. of branches
1. Earthquakes both sides of ocean	17	34	Geology—13 Physics—8 Environ.—7 Geog.—2	Literature—8 Internal data Base—15 Class—5 Press—1	2.5	20	1
2. Earthquake damage	33	45	Geology—12 Physics—4 Environ.—18	Literature—3 Internal data- Base—2 Class—6 Lab—1 Interview W/experts—3	2	16	1
3. Earthquakes in Israel	25	25	Geology—8 Environ.—3	Articles—1 Literature—5 Internal data Base—8 Class—2 Field—3 Interview W/experts—2 Press—3	2.6	18	1
4. Earthquakes in Eilat	35	25	Geology—15 Physics—3 Environ.—5	Articles—2 Literature—3 Internal data Base—5 Class—2 Field—5 Interview W/experts—1 Press—5	2.3	16	1
5. Earthquakes nuisances	20	30	Geology—12 Physics—1 Environ.—1	Articles—1 Literature—7 Internal data Base—4 Class—8 Press—2	4	13	2

Adding the computer to the project made the subject more interesting.

The subject itself is interesting and important, and combining it with the computer increased my interest. At first, I was nervous about working on the computer but in the end, I enjoyed it. Integrating the computer into learning contributes to increasing interest and it's more attractive to learn, especially when you add animation and sound.

Table 3
A Pre/Post Wilcoxon Matched Paired Comparison of students' attitudes toward presentation building as a learning too (Class 1). Scale = 1–5 (N = 12)

	Pre		Post			
Item	Mean	S.D	Mean	S.D	Sign Rank	p
Integrating multimedia presentation with the subject "earthquakes" increased my interest in this subject	3.6	1.8	4.5	1.1	10.5	0.02
The building of the multimedia presentation did not contribute to my knowledge about earthquakes	2.0	0.7	2.3	1.6	2.0	N.S
I am apprehensive about using the computer and multimedia in learning about other subjects	3.1	2.8	2.4	1.3	4.0	N.S
The presentation-building wasted too much time	3.1	1.3	2.0	1.1	10.5	0.02
I like to learn with the help of the computer	2.8	1.9	3.5	0.9	5.0	N.S

> *As a person who doesn't know anything about computers... I didn't enjoy learning the subject using the computer. Maybe if I was with someone who knew the computer better, I would have enjoyed it.*

The following quotes reflect the students' opinions about presentation-building as a learning tool:

> *The computer didn't add knowledge. The very fact that we entered the information into the computer meant that we had to understand it...*

> *Building the presentation made the job more interesting. It (also) made us review the material.*

> *We'll remember it better since we dealt with it for such a long time.*

> *What makes it interesting is the special effects... It could be that the students should find out about the effects only after they have built the outline. We tried to work that way but it was very tempting. Every picture that came up made us want to quickly add special effects.*

> *No one had enough time to prepare the presentation.*

The interview with the teacher highlights the motivational aspect of the multimedia project:

> ...The presentations were an excellent trigger for getting into the work and learning the topic. The proof is that students stayed here yesterday until late or else they asked permission to start earlier...

Discussion: Class 1

The synthesis of the students' cognitive and affective outcomes, together with the record of the presentation building allowed the researchers to summarize the impact of building multimedia presentations. There is clear evidence that the students in Class 1 perceived presentation-building as a process, which they enjoyed greatly, primarily because of the special effects in the software. Moreover, the students strongly felt that building the presentations raised their interest in earthquakes, as well as significantly affected their motivation to be in school. Finally, they believed that it contributed to their level of knowledge. However, this last perception was not supported from the cognitive outcomes. The content level of most of the presentations was poor, for the most part, because the students devoted much of their time to technical aspects of presentation building.

Thus, although presentation building motivated the students, such motivation was directed toward play rather than toward learning. It appears that the play aspect attracted the students to invest many hours, at the expense of their own free time, in order to create the presentation. Since the students invested many hours (20–30 hrs) in this task, one might expect that the content level would reflect their investment. In fact, it was quite poor.

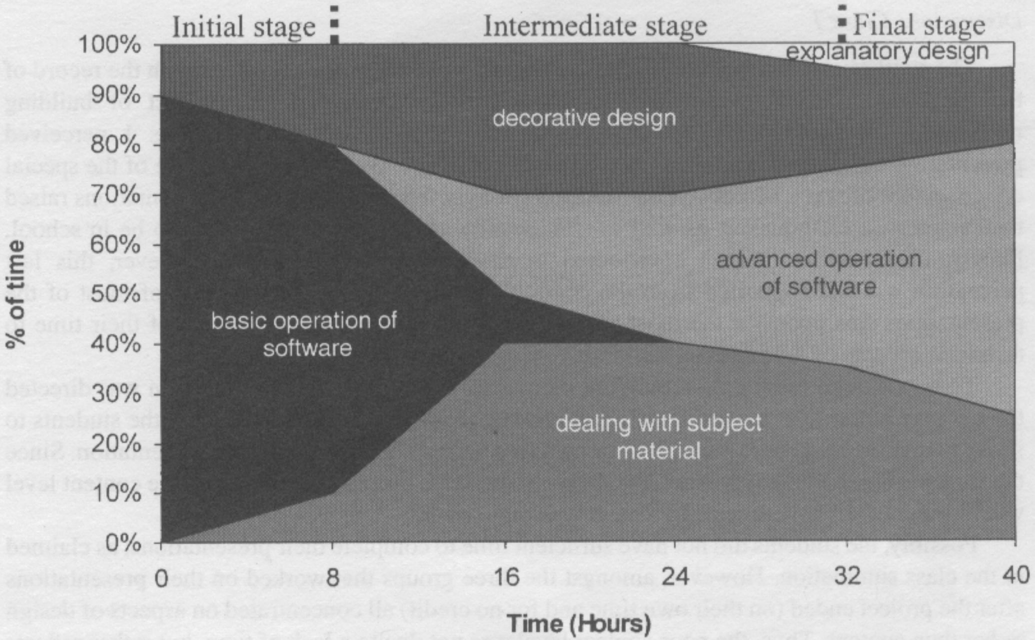
Possibly, the students did not have sufficient time to complete their presentations, as claimed in the class summation. However, amongst the three groups that worked on their presentations after the project ended (on their own time and for no credit) all concentrated on aspects of design rather than content. Thus, the poor content level was not due to a lack of time, but rather reflects the fact that the students concentrated on effects instead of content.

This suggestion is strengthened by comparing the working methods of groups 2 and 5, which shared the same subject. Group 2 received the highest grade for content and the lowest for design. In contrast, group 5 received the highest grade for design and the lowest for content. This comparison suggests that the investment in design came at the expense of investment in content. This suggestion is further supported by the lack of connection between different learning environments and fields of knowledge. Again group 2 (which invested in content) not only mentioned the key concepts, but also delved deeper into explaining them and their connections with geology and the environment.

Nonetheless, it is impossible to ignore those students who claimed that presentation-building helped them to understand the material better. It appears that these students did not carry out the self-study properly and arrived at the presentation-building with little material to integrate into their projects. They simply gathered the sources most accessible to them, including materials taken from the picture file or from class material. This also explains why most of the material was presented from the geological perspective, while other fields of knowledge were largely ignored. Gathering the material and integrating it into the presentation gave the students the impression of learning.

Results: Class 2

The cognitive and affective influence of all three phases of the unit (introduction, self-study, and the multimedia presentations) was evaluated by a pre–post comparison of the statement questionnaire, the concept maps and the two attitude questionnaires (the semantic differential and the Likert type). Based on this analysis, discussed in Dubowski and Orion (2001), it emerges that, at the cognitive level, the program contributed to a significant increase in the students' knowledge. In addition, the students in this class internalized the connection between earthquakes and their social and environmental consequences.



Initial stage
Intermediate stage
Final stage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% of time
explanatory design
decorative design
advanced operation of software
basic operation of software
dealing with subject material
0
8
16
24
32
40
Time (Hours)

Figure 2. Distribution of activities during presentation-building (Class 2)

Here, again, the authors will try to ascertain the influence of building multimedia presentations on the cognitive and affective outcomes.

Characterizing the Presentation-Building Phase. The observations summarized in Figure 2 indicate the following stages in the presentation design process:

1. An initial stage lasting approximately 8 hrs, in which most of the time was devoted to technical issues and decorative design. The students learned ASTOUND's capabilities and concentrated their efforts on special effects, such as adding color, sounds; and animation.
2. An intermediate stage, of about 24 hrs, in which the students dealt with content, although 65% of this time was still focused on technical aspects. At this stage, the students began working with more complex technical elements, such as testing special effects; control command capabilities; synchronizing objects and recording voices.
3. A final stage that lasted approximately 8 hrs, in which the students prepared their presentations for screening. Involvement with subject matter declined sharply, with most of the effort devoted to complex technical aspects. A few of the groups did begin explanatory design.

Two important findings are suggested by the observations made during presentation-building:

- Only a small amount of time (less than 35%) was invested in content.
- Several groups managed to cope with explanatory design by the end of the project, but only with few slides.

The Influence of Presentation-Building on Knowledge. Similar to Class 1, we tested how presentation-building affected knowledge, by analyzing the presentations, the interviews, and by comparing the students' flowcharts with their final presentations.

Analysis of the presentations showed the following:

Content analysis: An analysis of the quality and scope of the content in the presentations shows that the level of grades ranged around 90. Such high grades indicate that the independent study phase contributed considerably to student knowledge.

Structure of the presentations: Three of the four groups used a similar number of slides (ranging between 39 and 52); one group had 96 slides. Each presentation had a main menu and additional sub-menus.

Design of the presentations: Three of the four groups received a design grade ranging between 1.7 and 2.1; this indicates that, as with Class 1, most of these students did not take advantage of the explanatory potential inherent in ASTOUND. Further, it highlighted the fact that the students did not understand the difference between written papers and multimedia presentations.

Integration of knowledge obtained from different learning environments: Most of the groups referenced a variety of learning environments and information sources in their work. The major source of information was articles and professional literature, but several of the groups also downloaded sources from the Internet or video-taped interviews with experts. All of the presentations used material gathered from educational field trips. Groups 1 and 3 drew upon the broadest variety of learning environments. (It should be noted that before beginning their projects, students were given instructions emphasizing the need for different information sources.)

Integrating knowledge from various fields of science: In four of the presentations, the groups focused on geology, and after that, on the environment. In most of the projects there is a correlation between the number of concepts associated with a certain topic and the level of the students' understanding demonstrated in the presentation. The environmental perspective was specifically highlighted in presentation 3. Presentation 2 integrated many fields of knowledge, quoting the Bible, historical testimonies, and experimental results to better illustrate how tsunamis affect coastal populations.

Table 4 indicates that most of the students in Class 2 (meaningfully) integrated different learning environments and fields of knowledge in their presentation.

In order to test the effect of presentation-building on individual students, a comparison was made between the presentation grades and the concept maps prepared by each member of the group. It was found that only with groups that worked in a fully cooperative manner were the individual concept maps replete with interconnected concepts from all subjects in the presentation.

However, in groups which worked by a division of labor, where each student was responsible for a certain chapter, there was no correlation between the quality of the presentation and the quality of the individual concepts. Indeed, a correlation was only found for the student who planned the overall structure of the project, whereas his team members' maps consisted mainly of concepts from the chapters that they had developed. Other researchers (Chang & Lederman, 1994; Kempa & Orion, 1996) have made similar observations in their studies of group dynamics in cooperative learning.

This finding demonstrates that preparing presentations in a group is no guarantee that a process of knowledge integration has taken place. It is very important to teach students cooperative work habits, so as to avoid a division of labor.

Table 4
Analysis of the presentations (Class 2)

	Content				Design	Structure	
Subject	Scope of project (0–40)	Quality of work (0–60)	Connections to subject areas	Learning environment & sources	Grade Scale 1–5	No. of slides	No. of branches
1. Tsunami	37.5	54	Geology—18 Physics—5 Environ.—15 Bible—9 Biology—3 History—16	Articles—14 Literature—35 Internal data Base—9 Class—2 Field—2 Interview W/expert—1 Internet—3 Press—1	2.7	39	9
2. Predicting earthquakes	30	54	Geology—25 Physics—5 Environ.—15 Chemistry—2	Articles—15 Literature—16 Internal data Base—12 Class—7 Field—2 Interview w/expert—12	2.1	52	6
3. Earthquakes the Eilat region	38	58	Geology—68 Physics—11 Environ.—34 Geog.—9	Articles—40 Literature—40 Internal data Base—308 Class—12 Lab—3 Field—7 Press—3	2.2	96	18
4. Evaluating seismic risks in Eilat	37	54	Geology—26 Physics—6 Environ.—12 Geog.—3	Articles—24 Literature—9 Internal data Base—15 Class—2 Field—1 Press—75	1.7	48	11

From a comparison of the subjects listed in the flowchart, prepared by the students during the initial stage of presentation-building, there were few conspicuous differences with the subjects represented in the final presentation. However, wherever there was a difference, it was always in the direction of adding topics to the final presentation. Table 5 compares the flowcharts of two groups with their final presentation. It shows that one group (project: Tsunamis) had a significant increase in the number of concepts and branches post program. This suggests an increase in the complexity of the students' knowledge structure during the presentation-building process. However, this significant increase was unique and was not found in other groups.

Table 5
A comparison between the flowcharts and presentations of two representative projects from Class 2

Presentation	No. of cells in flowchart	No. of slides in presentation	No. of branches in flowchart	No. of branches in presentation
Tsunamis	29	39	4	9
Seismic risks in Eilat	41	48	8	11

The students' attitudes toward multimedia presentations as a learning tool were tested using the (Likert) attitude questionnaire as well as the summary class discussion.
Table 6 indicates the following findings:

1. The students came to the project with high expectations regarding multimedia as a tool that motivates interest and contributes to knowledge.
2. After the program was over, there was a significant decline in student attitudes toward the contribution of presentation-building; concurrently there was an increased interest in learning about earthquakes.
3. There was a significant decline between the students' pre-program expectations and their post-program attitudes, with regard to the contribution of building multimedia presentations about earthquakes.
4. There was significant agreement that presentation-building took too much time.

These findings indicate that the students in Class 2, as opposed to Class 1, felt that building presentations did not contribute towards increasing their knowledge and interest in the subject being studied. This outcome contradicts the findings of Hay et al. (1994) who argue that building presentations arouses interest in the subject being studied.

Table 6
A Pre/Post Wilcoxon Matched Paired Comparison of students' attitudes towards presentation-building as a learning too (Class 2). Scale = 1–5 (N = 17)

Item	Pre		Post			
	Mean	S.D	Mean	S.D	Sign Rank	p
Integrating multimedia presentation with the subject "earthquakes" increased my interest in this subject	3.8	1.5	2.9	1.9	10.0	0.02
The building of the multimedia presentation did not contribute to my knowledge about earthquakes	2.3	0.8	3.2	2.2	17.5	0.01
I am apprehensive about using the computer and multimedia in learning about other subjects	2.4	1.5	2.6	1.7	1.5	N.S
The presentation-building wasted too much time	2.7	0.8	3.5	1.5	23.5	0.002
I like to learn with the help of the computer	3.0	2.4	3.1	1.5	1.5	N.S

After the projects were screened, the students were asked to express their opinions about presentation-building as a learning tool. Below are several quotes, which summarize their attitudes:

> *...Building the presentation didn't help me to understand the subject; on the contrary, the work was frustrating, due to technical problems.*
>
> *We spent too much time building the presentations. It is interesting... It's neat to build a presentation with all the tricks...but it took a lot of time.*
>
> *I learned a lot less about earthquakes than I did about computers.*
>
> *The work on the presentation didn't increase my knowledge about earthquakes. The information about earthquakes I got from the classroom lessons and the written paper.*
>
> *It really bothered me that I didn't really understand what was expected of me in the presentation. ...Only now I realize that I actually missed the point and what we should have done was not just to transfer the written work to the computer, but to try to present our findings and ideas differently...*
>
> *...We had the written material when we came to build the presentation, but we got new ideas all the time... there were subjects we preferred to rewrite and while rewriting them, questions came up which we asked each other or we asked the researcher.*

The interviews show that the students were sometimes frustrated by technical difficulties, and lack of time. They also claimed that building the presentation did not contribute to their level of knowledge, although based on one student's reply there appears to be a certain "dynamic" in organizing the material. However, the general impression is that these students related to learning as a process of learning something new, rather than as process of knowledge organization. Moreover, students did not realize the difference between a written paper and multimedia presentation.

Discussion: Class 2

An analysis of the presentations' content indicates that the students had a command of the material and were even able to integrate different learning environments and fields of knowledge into their projects. However, this mastery does not stem from presentation-building itself. In the interviews, as well as in the questionnaires, the students contended that they came to the presentation-building with the work already prepared, and all that remained for them to do was to enter the material into the presentation. Indeed, in most cases, there was no difference between the written work and the presentations. This is suggested both by the mid-range grades they received for design, and by the similarity between their (pre-presentation) flowcharts and their final presentation.

Most of the students enjoyed designing the presentations, especially the special effects, as well as showing it to the class. However, this positive attitude was mingled with a feeling of stress that developed due to time limitations and technical problems associated with the projects. However, for some students, building the presentation did help them to better organize the material.

Discussion

The observations from this study indicate a fairly uniform model of presentation-building characterized by the following stages:

1. Initial stage—discovering the software's capability.

During this stage the students discover the various tools related to presentation-building. First, they learn the basic tools: text, picture, and basic slide design. After mastering these activities, there is a demand for more complex tools: determining background color and pattern, timing the entry of objects, transitions between slides, scanning in pictures, and adding animation. This stage is accompanied by the motivation to explore all of the software's capabilities.

2. Intermediate stage—combining content and design.

At this stage students begin to deal with content. Students begin the process of replicating their research activities, which leads to rephrasing, summarizing, focusing on important material, and group discussions. Concurrently, it is important to stress that approximately 30% of the groups' time is focused on building the presentations. After choosing the presentation format, a considerable amount of time is invested in designing and timing the slides. Most of the groups deal with decorative design at this stage, some with connected design, and only a few with explanatory design.

3. Final stage—completing the presentation.

At this stage, students emphasize design and timing of the presentation, continuously reviewing it so that it would flow smoothly. Finally they present it before the entire class.

An analysis of the direct observations reveals two significant points:

- Dealing with content at any stage never accounted for more than 30% of the time.
- Only a small number of students exhibited explanatory design in their presentations, and even when exhibited, it was present in a few slides only.

These findings support Turner and Dipinto (1992), who note that in order to build presentations, students are required to develop computer skills which are not directly related to the learning process. Only one group in Class 1 focused on the content. It was also the only group, which did not focus on the software's capability, suggesting that preoccupation with design not only wastes valuable time, but also diminishes the students' concentration on the subject matter. This is reinforced, both by the results obtained in the attitude questionnaire, and in interviews with students in Class 2 after finishing their presentations.

Interestingly, it was the students of Class 2 (who had prepared in-depth presentations) that claimed that building the presentations did not add to their knowledge. In contrast, the students of Class 1 (who had prepared presentations with a shallow content level) claimed that they had gained knowledge from the presentation building.

This difference might be connected to the different characteristics of the students in the two classes. It was also affected by the students' independent studies, as well as the different times of the year that the program was implemented.

The students of Class 1 had low academic motivation. This is evinced by the fact that these students arrived at the presentation-building stage without the proper background in the subject, largely because they had completed the independent study stage superficially. When the students were exposed to ASTOUND they were enchanted by its possibilities for "play." Soon enough they discovered that, in order to use the software, they needed a specific subject. This forced them to do what they had not previously done, open their textbooks and deal with content.

However, these students did not advance much beyond the "textbook" stage. They simply returned to the subjects learned in the geology class (such as plate tectonics), as well as to the most accessible sources of information, such as the school library and the picture file. The moment they had accumulated minimal content, they returned to playing with the software, and stopped dealing with content. This scenario explains the low level of content in their presentations. Moreover, since they simply recycled their present level of geological knowledge without delving deeper into topics such as the environment or physics, there was no significant improvement in their knowledge. In contrast, only one group did not focus constantly on the software, and so was able to delve more deeply into content.

This scenario supports the arguments of Clark and Salomon (1985) who found that the great enthusiasm that students show for multimedia work stemmed from its play aspect. However, as the researchers show, play distracts attention from the learning process.

Johnstone (1980) and Johnstone and Wham (1982) present a similar scenario in their study of students' working habits in the chemistry laboratory. They suggested that such "play" might reflect the students' reaction to the stress of dealing with a high information environment. To relieve such stress students will often adopt an approach in which they will busy themselves with non-essential tasks that have little connection to their work. They believe that doing such tasks is part of their learning, rather than organizing the information they have learned.

At the same time, the fact that students with low academic motivation perceived a school activity as an enjoyable learning experience is an important finding. Possibly, presentation building has the potential for increasing the motivation of normally unmotivated students. There is little doubt that the results obtained from Class 1 were poor; however, it is possible that these students' next encounter with a similar experience might, with the right guidance, lead to more meaningful learning.

The source of negative attitudes toward presentation building amongst the students of Class 2 might be connected to the difficult learning conditions associated with the project. These include the pressure of time due to their matriculation exams, as well as technical problems that hindered their work. It is also possible that such attitudes influenced the other results found for Class 2. This might lead one to suggest that the benefits of creating multimedia are contextual rather than causal. Although the authors do not believe that it is possible to conduct "pure" causal research in the classroom, it is crucial to clarify that such an argument should not cause this study to be labeled as contextual or contingent. The following are the reasons for this claim:

1. As noted in the introduction, several studies (e.g., Clark and Salomon, 1985; Hay et al., 1994; Turner and Dipinto, 1992) discovered similar difficulties with designing multimedia presentations. Technical problems and time-consuming methods are integral components of the educational system. Indeed, they are components in the same way that proper laboratory apparatus are integral parts of the school laboratory environment, or as physical conditions are a part of the outdoor learning environment.
2. The frustration expressed by several students did not interfere with their learning. On the contrary, since the multimedia presentation was part of their matriculation exams, they invested much time completing these assignments. Thus, there is no evidence suggesting that the affective domain influenced the cognitive outcomes.
3. The students of Class 1 expressed positive attitudes toward the presentations and they were not under the pressure of the matriculation exam period. However, in comparison to Class 2, their cognitive outcomes were lower.

Thus, we suggest that a more reasonable explanation for Class 2's results is due to the fact that in this Class, most groups completed the self-study phase with comprehensive written papers. They therefore completed this stage with the feeling that it indeed deepened their knowledge on the subject of earthquakes. However, the interviews indicate that they did not understand the differences between a written paper and a multimedia presentation and thus, they were not sure why they had to *copy* their work into the computer, forcing them to waste valuable time learning how to use an unfamiliar tool.

A possible source of this problem is that these students, like most Israeli students, have always been accustomed to handing in written papers, with an approach that "the greater the length the better." This attitude conflicts with the essence of presentation-building. On the one hand, they wanted to put all of their research material into the presentation. On the other hand, they noted that a presentation consisting only of text does not look good. As we saw from their presentations, these students did not forgo putting a relatively large amount of textual material into the computer and they solved the problem of making it interesting by adding pictures (generally decorative, on a background of text). Further, they added lavish special effects for the texts and slide transitions, as well as adding melodramatic narration and background music.

Hay et. al. (1994) note that presentations permit freedom of expression and encourage creativity. However, as seen in this study, in order to foster such creativity, the student must first understand what the desired product of his presentation-building will be. It should be noted that the before beginning the final presentations the students were told that such work should have a strong visual element. However, the process of paper writing is so deeply ingrained that it is not enough to "tell" the students; cogent methods must be developed so that students will internalize the idea of explanatory design, the chief advantage of a multimedia presentation.

Hay et al. (1994) arrived at a different understanding of the learning potential of multimedia presentations, but it should be noted that the MEDIA TEXT software used in their study possessed none of the features of explanatory design. Since the two programs have different work styles and features, it is difficult to compare their learning potentials. Deciding such factors is dependent on which type of software is used to build the presentation. Thus, it is only by comparing studies in which the same software was used (or at least from the same family), that it is possible to decide on common characteristics. In addition, future research on characterizing presentation building should also focus on explanatory rather than decorative design.

In an interview with a student of Class 2, from the group in which the most significant advance took place from the flowchart to the presentation, he insisted that the presentation did not contribute to his level of knowledge. At the same time, he noted that in the course of the presentation building, discussions developed among the group members, new ideas were raised, and texts were rewritten. Possibly, the discrepancy between the student's assertion that presentation building did not add to his knowledge and what he said later is evidence that the students do not regard the process of reflection as one of adding information. Thus they are unaware of the cognitive processes occurring during presentation-building.

Kozma (1991) maintains that building presentations focuses the student on the connections between ideas and this encourages the transfer and sharing of information from various fields. Hay et al. (1994) point to an additional cognitive aspect related to multimedia presentation-building. It encourages students to integrate knowledge acquired in different learning environments. However, analysis of the presentations from Class 1 contradicts this argument. In this class (unlike Class 2) the presentations did not integrate different learning environments and fields of knowledge.

These findings do not cancel the findings of Kozma (1991) and Hay et al. (1994). However, they indicate that building presentations of itself does not necessarily lead to the integration of learning environments and fields of knowledge. Such integration can be achieved using means which are simpler and more readily available.

Conclusions

The following are the major conclusions of this study:

1. This study did not find evidence that presentation building (using ASTOUND) contributed to an increase in knowledge, nor to an integration of different fields of knowledge and learning environments. There was evidence that building multimedia presentations influenced some of the students to reflect upon and organize the information they had gathered during the presentation-building stage. However, this evidence is insufficient to evaluate the effect of presentation building (using ASTOUND).

2. Three stages characterize the presentation building process:
   - An initial stage in which students discovering the capability of the software.
   - An intermediate stage in which students deal (often superficially) with content.
   - A final stage in which the students finish and screen their presentations.

In each stage the students focused on technical aspects of presentation building.

3. Three problems were associated with the learning strategy developed for this program:
   - *Technical distractions*: The students encountered a variety of technical problems associated with computer use. Thus, building multimedia presentations without the necessary technical support may jeopardize the project's success.
   - *Time*: In order to build multimedia presentations, time must be devoted to learning a number of fundamental computer skills needed for the design process. These include learning how to effectively manipulate the necessary software and hardware. Moreover, time is required for building the presentation itself. The amount of time is also dependent on the creativity of the student, since the most difficult part of this process is creating presentation ideas rather than just implementing them. All of these factors require time, a limited resource in the educational system.
   - *The software itself*: This study shows how easy it is to become submerged in "design games" at the expense of dealing with content. The vast range of possibilities offered by ASTOUND is both an advantage and a disadvantage. The largest disadvantage found in this study is that its visual effects entice the students into "playing" at the expense of focusing on learning.

4. The students' failure to utilize the educational potential of the multimedia environment was due to a series of factors. The most prevalent was the students' failure to distinguish between the objectives of a written paper and a multimedia presentation. In order to take advantage of the unique potential of a multimedia presentation, the ability to create visual explanations, students must first learn the essence of explanatory design as well as the technical skills necessary for manipulating the required software.

5. This study suggests that students with low academic motivation might find the play aspects of multimedia (such as ASTOUND) an incentive toward learning.

Practical Recommendations

In order to translate the findings of this paper to the practical world of the classroom, the authors suggest the following recommendations as a guide for teachers who would like to develop multimedia projects with their students. Such recommendations can be divided into organizational and pedagogical concerns.

It is exceedingly important that the students receive the proper equipment and technical support. Thus, each group of three students should be provided with a 486 computer (or better) with at least 8Mb memory, sound card, and loudspeakers, as well as access to scanners and picture-processing software. Video cards and an Internet connection are also highly recommended.

The project should be an integral part of the teaching program. The teacher should design a proper teaching schedule needed to direct this program both in the classroom and in the computer room. The school should also schedule the program in advance so that both the computer room and a computer technician are available.

The students should arrive at the presentation-building stage following a learning unit, which provides them with a basic understanding of the subject. This will allow them to more readily select the subject of their independent study. Before starting this phase of the project, it is important to inform the students that they must collect information from various learning environments (classroom, lab, field) and information sources (text, Internet, interviews). The authors also recommend that presentation-building begin only after building an accessible computer database which is relevant to the subject being studied.

Most importantly, the student should learn about the differences between written papers and a multimedia presentations. This can be done by providing examples of multimedia projects, which emphasize their key characteristics. At the same time students should receive practical experience by designing a few introductory slides which the teacher would then critique based on the criteria discussed in this paper.

In the Appendix to this paper is a section from the guidebook that was developed to instruct students about presentation building. In this stage it is important to build a schedule which would include the following topics:

1. Explaining the key differences between multimedia presentations and written papers (1 lesson).
2. An introductory lesson with the multimedia software (4–6 lessons).
3. Organizing the database subjects via a written flowchart.
4. Using the flowchart as the basis for designing the structure of the presentation (i.e., the slide titles and the connections between them).
5. A Class discussion on how one might utilize the different software tools in order to build concrete, visual explanations within their slides. This session should therefore focus on the difference between explanatory and decorative design (1 lesson).
6. Group discussions on using the software to build concrete visual explanations of their specific subject. In essence this is an in depth continuation of stage 5 (3 lessons).
7. Designing the presentation (10–20 lessons).
8. Submitting a draft of the presentation to the teacher in order to receive feedback.
9. Group presentation of the final multimedia projects.

Suggestions for Further Research

The following are several suggestions for further research into presentation building:

1. Characterizing the educational product of students who deal with explanatory design in building multimedia presentations.

2. Evaluating the changes in a class' ability to build multimedia presentations through a series of projects.
3. Classifying the changes, which take place in the organization of knowledge as a result of building presentations. This could be done by monitoring the students' knowledge before and after work on the presentation, as well as through meticulous observation of the presentation-building stage.
4. Comparing the cognitive and affective products of students who build multimedia presentations on the same topic but using different types of software.
5. Monitoring the effect of timing on presentation-building. For example, presentations that are built after the stage of independent research versus presentations which are built as part of the research process itself.

Appendix

This Appendix presents the first four pages of the booklet "Introduction to multimedia presentations-Authoring with ASTOUND" that were written as part of the current study.

1. Introduction

The multimedia presentation is a tool, which permits you to present and explain any idea by integrating various presentation tools: text, voice, picture, illustration, animation and video clips.
This spectrum of media enables a qualified user to present his ideas in an interesting, concrete manner.
The following material will explain both the technical and pedagogical elements of designing educational presentations using the multimedia software ASTOUND.

An old Chinese philosopher once said, "a picture is worth a thousand wards". Now try to imagine what he might have said about multimedia presentations

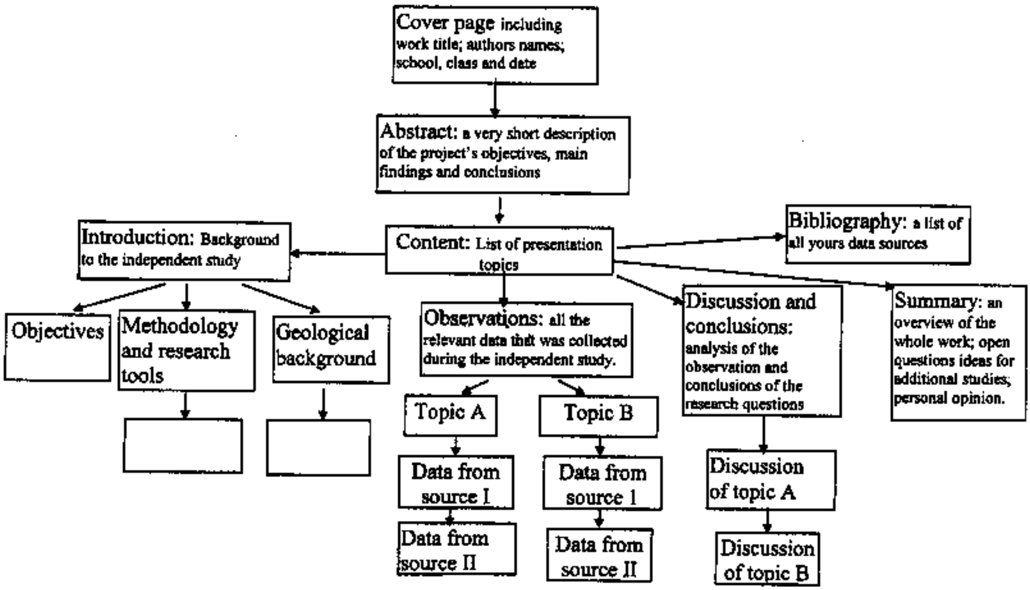
2. General instructions for multimedia authoring

The following instructions focus on presentations that are developed in order to summarize an independent project on a specific research question, permitting one to present an oral presentation on this subject. The authoring process is divided into five steps:

a. Organizing knowledge through a flow chart design

This stage begins only after completing the independent study in which you will collect the necessary data. This is the most important part of presentation building. In this stage you have to think thoroughly about the content and organization of the presentation. First, organize all the materials that you have collected and which you intend to present. This includes: data from your own research, as well from experiments; articles that you have read; data based on recorded interviews with experts; pictures that you have photographed or downloaded from the internet. The next stage is to organize what you would like to present in the most clear and coherent way.

Tip1: try to describe your presentation through a flow chart
The following is an example of a possible flow chart:



Tip 2: Be aware!!!

It is very tempting to focus on the presentation's decorative design by using the software's special effects at the expense of dealing with content. Therefore, it is crucial to deal with the effects only after you have built the contents and the structure of your presentation. Please, pay attention to this warning! The main objective of your presentation is to explain and present the independent study that you have completed. Thus, content is the most important aspect of your presentation!!!

b. Creating the slides
Only after completing stage A should you open the ASTOUND software and start to create the slides based on your flow charts. First (before entering content) you should give each slide a name. By doing this you create the backbone of your presentation, in which you will then enter the content of each slide and the transitions between slides. Be aware, that the original flow chart is usually modified during the later stages. Detailed instructions are found in section 3.

c. Importing the content for each slide and adding the control buttons
This is a technical stage in which you import the slides' components to the slide screen and add the control buttons, which permit movement between slides.

d. Design and timing
Remember that a presentation is not a written essay! Its main advantage lies in its ability to explain a subject using different media and dynamic pictures and texts. Timing the appearance of various objects within a specific slide, the way they appear, integration of graphs, adding of pictures with explanations and voices are only a small part of the ASTOUND. However, at this stage, it is not recommended that you use these effects since you might end up wasting valuable time. Let your imagination and creativity lead you, but at the same time, try to use only those effects that lead to a better understanding of your topic.

e. Screening and proofreading your work

The last stage is very important, since there is always something to correct, or modify. For example, check if each of the slides can be opened; check their timing; check if the background colors do not mask the text; and most importantly, permit a friend to run the presentation so that you may receive his feedback.

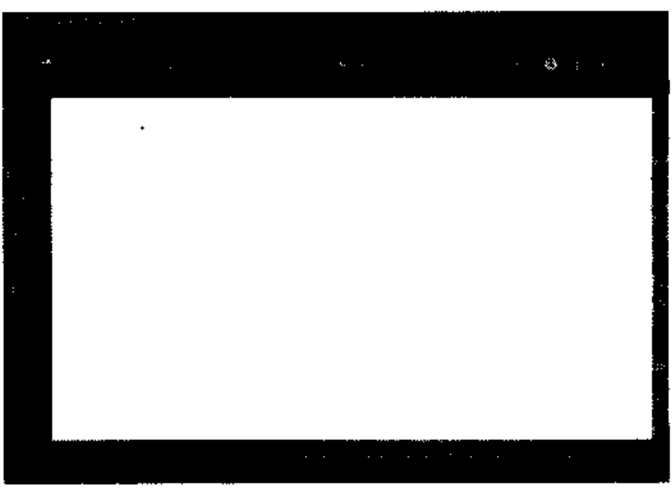
3. How to create an ASTOUND presentation

The ASTOUND presentation is built as a series of slides, but in contrast to regular slides, it has dynamic features. You can control its length, time, appearance, running order and slide transitions.

1. Opening the Astound software and building a new presentation

Open *Windows*; locate the Astound icon and open it by double clicking so that the next appears.

—Click the button *Create with no template* and the screen below will appear. This sereen is used for editing the slides.



The left margin contains various editing tools. The software includes options, but in the next page we will learn how to use the most important basic tools.

3.1 Important function buttons:

Save Print Undo Cut Copy Paste

Zoom Color

Run whole presentation

Run slide Timing slide's objects

Slides show

Text/**Font

Geometric forms/*Select form

Add Text buttons

**Add picture

**Add video clip

**Add animation

**Add table/graph

Add voice/music

*** Short click**

**** Double click**

*Create new slide

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