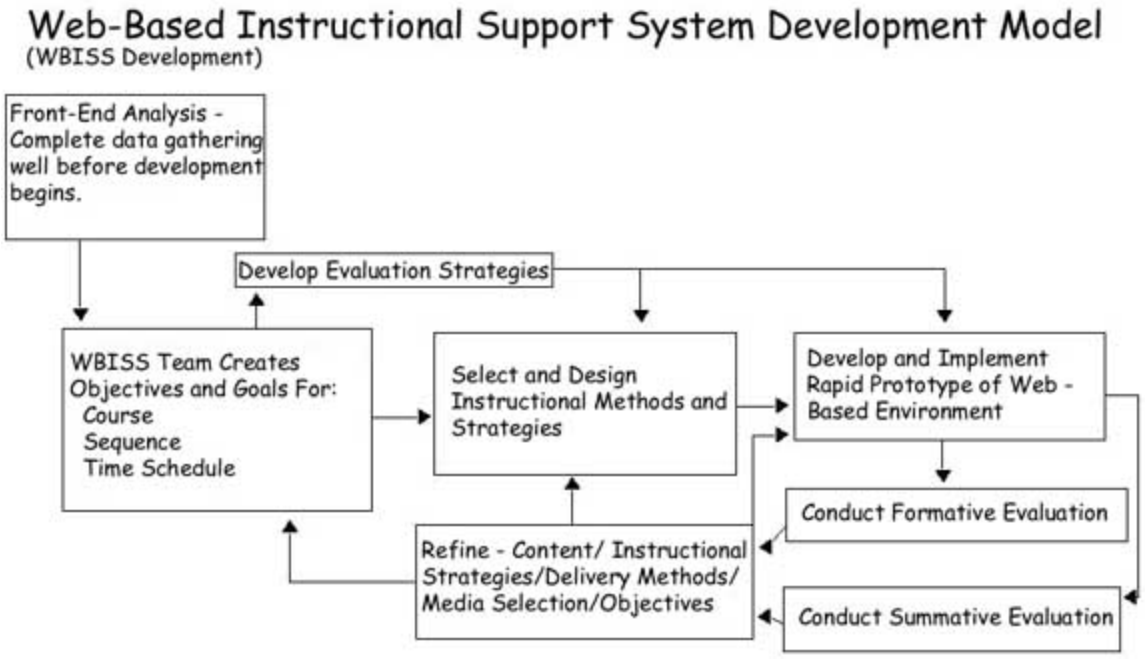
Rapid Prototyping of Web-Based Instructional Support Systems for Introductory College Science Environments



Aaron Fried
IDE632

Table of Contents **Page Number**

Context and Background 3

Target Audience & Assumptions 6

Organizational Structure 8

WBISS Team Members 8

SME (Subject Matter Experts) 8
Web Author/Technician 9
Media Specialist 9
Instructional Developer 10
WBISS Manager 10

WBISS Development Model 11

Front-End Analysis 12
WBISS Team Creates Goals and Objectives 15
Define Evaluation Strategies 16
Select and Design Instructional Methods and Strategies 17
Develop and Implement Rapid Prototype of WBISS, Evaluate, Revise 21

Management Issues 22

Planned Change Issues 23

Summary 24

References 25

Appendix 1 – Goals of the Society for College Science Teachers 28

Appendix 2 – Major Challenges for Instruction of Large Classes 29

Appendix 3 – Potential Gaps Created by Large Classes 30

Appendix 4 – Roles and Responsibilities on the WBISS Team 31

Appendix 5 – WBISS Development Model 32

Appendix 6 – Front-End Analysis Plan 33

Appendix 7 – References for Writing Educational Objectives 34

Peer Review – By Rashell Clarke

WBISS Model Presentation

I.D. Model Interim Report

Context and Background: (Table of Contents)

More colleges and universities are requiring students to complete a very broad training in the liberal arts. Students must take general courses in American history, fine arts, cultural backgrounds, technology, literature and natural sciences. As a result, courses that fill the requirement for general liberal arts credits are gaining a diverse population of students with a variety of backgrounds, interests, and prerequisite skills and knowledge. Biology, Chemistry, Earth Sciences, and Physics departments must come up with courses that meet the liberal arts requirements.

College science courses present many issues that can uniquely affect the quality of instruction. These problems can range from gender and racial equity issues to the monetary issues associated with taking a science course (e.g. paying for expensive texts, lab fees, lab manuals, etc.). Additional challenges arise when colleges and universities are charged with the task of providing a quality science education to non-major students for the purposes of general liberal arts education. The effect, when coupled with financial concerns, is increasing class size and general science courses with large and diverse student populations at different levels of learning.

Large science classes have the potential to create educational gaps that require solutions from colleges, universities, and their departments and faculties. Maryellen Weimer (1994) suggests seven major challenges for large course instruction (Appendix 2). Among those challenges are 1) making learning active, 2) personalizing content and classes, 3) working with diverse student backgrounds (prerequisite skill and knowledge) and student preparation, 4) student assessment, and 5) instructional adaptation. In addition to Weimer's challenges, effective communication can become impaired when

institutions create several lecture sessions and numerous lab/recitation sections in order to deal with high volumes of registration. A large course system could include several professors, several more instructors, numerous teaching assistants and tutors, and maybe 500 to 1500 students. Coordination of these courses can be a daunting task. Additionally, this system creates a problem with providing an equal and individualized instructional program for individual students.

Previous educational strategies for improving large class instruction included interactive lectures, effective questioning, small group discussion, problem solving, class debates, simulations, and role-playing (Lumsden, 1997). While these methods and strategies are useful, emerging technologies and the World Wide Web may provide an opportunity to increase the effectiveness of large class science instruction. By creating a web-based instructional support system (WBISS) that ***supplements*** the traditional classroom and coursework, institutions can foster individualized instruction and help to level the playing field between different sections of lectures and labs.

Creating a WBISS will help combined teams of faculty to accomplish several goals and address gaps created by large courses (see figure 1). The WBISS will help faculty teams create contiguous and uniform instruction, improve faculty and student communication, provide continuous course information, documentation, support, and allow the students a forum for self-assessment (Jones and Liu, 2001, Dijkstra, Collins, and Eseryel, 2002, Cennamo, Ross, and Rogers, 2002). Additionally, the WBISS could be created in order to provide a hyperlink rich environment in which the students could jump from course related information to areas of information that interest the student. Creating these connections between current course material and areas of interest could

help to motivate student learning, as well as increasing the transferal of course content into other contexts and into an individual's own life.

Potential Issue in a Large Science Course	How WBISS Will Help to Address Problem
Learning is not active.	Students can work interactively with the hypermedia on the WBISS and increase their active participation in a course.
Class is less personalized.	Students can work in a hyperlink rich environment and meet their own educational requirements as they are suited to their educational field.
Work with diverse learning needs and preparation levels.	As above, students can work in a rich hyperlink environment. In addition, students that lack an educational background in a topic can be directed to supplemental tutorials that are directed by the course needs instead of general tutorials that might be found in textbooks or generalized course supplements.
Assessment of learning.	Online assessment, both for practice and credit, can provide students with immediate feedback about their learning.
Lack of communication.	An online environment could allow for rapid communication with instructors outside of normal office or operating hours. Additionally, bulletin boards and chat rooms would allow students the ability to ask questions of instructors or other students either synchronously or asynchronously. This also allows groups to meet and plan without physical meeting places. Additionally, answered questions are documented for later retrieval.

Figure 1 *– Meeting potential educational gaps with a WBISS.*

Real world limitations are an important factor in creating WBISS and a WBISS team. Creating the WBISS will take valuable resources, such as time and faculty involvement, so the task of creating a perfect WBISS in a short time would be impossible. Trying to create the WBISS for an entire course at one time, perhaps before the semester, is feasible. However, it may make more sense for a WBISS team to have a rapid prototyping development plan in order create an effective web-based environment (WBE) over the time period of the course.

A rapid prototyping development scheme that would allow the WBISS team to develop the WBE over the same time period of the course might be helpful in several ways. Planning and evaluation sessions could be integrated into larger course planning meetings that already exist on a regular basis. This would mean that the WBISS team

would have the ability to receive input from all faculty members working with a course in a timely manner. If the development took place over the course of a semester, students would be able to contribute formative evaluation that is more relevant to individual modules, units, or lessons. This is an important idea. If the WBISS team were to wait for summative evaluation at the end of a course, the feedback would most likely be more general and would not help in the revision of the individual modules.

Implementation of a WBISS rapid prototyping development model will help to make the course content more contiguous and uniform across the levels of lecture, lab/recitation, and supplemental instruction sections. WBISS content will be planned and implemented along with (i.e. at the same time as) the content of the course. This will allow the WBISS team the ability to examine the goals of instructors at the various levels of an individual science course (lecturers, lab/recitation instructors, TAs, tutors) and help to avoid redundancy. By planning the WBISS content as the course unfolds, irrelevant information or topics that might not be covered might not receive WBISS attention.

Target Audience & Assumptions: (Table of Contents)

There are several assumptions that underlie this development model. These assumptions are based on the typical organization of a typical large population college science course. Large science courses can involve a number of instructors. Faculty rank can range from Professor to Adjunct status. In addition, many levels of graduate students, college seniors, education students, and peer tutors could be involved with the instructional system. This development model will assume the following instructional system of organization. Students in this system are required to attend two or three one-

hour lectures a week and one three-hour lab/recitation. There may be one or more lecture sections. These sections might be taught by one instructor, but are more likely to be taught by several different faculty members. Lab/recitations are designed with smaller classes in mind. For every large lecture section, there might be five to eight lab/recitation sections. These lab sections will be taught by a number of instructors or graduate assistants. Finally, either the science department or an institution's Academic Services will provide peer-tutoring services for the course.

This model assumes these three levels of instruction. The WBISS team is built around this assumption. The target audience for this development model is the faculty for these large population science courses. In addition, other relevant department faculty might be interested in the implementation of this plan. For example, some departments have technology officers or curriculum development committees that would also be integral to the success of the creation of he WBISS.

The second assumption is that the institution has Internet connectivity and that there is some institutional committee that oversees the usage and implementation of the Internet for academic purposes. Without a department having institutional Internet connectivity, the financial cost of implementing a WBISS would be impractical. Institutions may be able to use web-based knowledge management systems in order to implement a WBISS. Blackboard.com, for example, offers users a chance to purchase space on their servers for uploading course materials. This option might prove problematic depending on the amount of customer service available. It may also be necessary for the department to seek to fill technical positions on the WBISS team with

technical support staff from the college or university if such persons do not exist within the department.

Organizational Structure: (Table of Contents)

Although several existing instructional systems development models (Lee and Owens, 2000, Cennamo, et al., 2002, Diamond, 1997) present different ideas about the composition of development teams, the idea of having a development team is essential to the development of a WBISS. Creating a WBISS team is an important consideration. This is not only due to the fact that a team may develop excellent subject matter, but also so the team can make realistic decisions based on the tools and resources available at the institution (Lee and Owens, 2002).

It is important to create a team that will best represent the course that the WBISS will support and the limitations of the institution. It is essential to choose a team that will accept both the role and responsibility of their position on the team.

Team Members: (See Appendix 4 for additional descriptions) (Table of Contents)

Subject Matter Expert (SME): This position on the WBISS team will serve to inform the WBISS team about the content for the web environment. Based on the large class scenario for this development model, there should be at least three subject matter experts on the team. One person will represent the lecturers; one person will represent the lab/recitation instructors; one person will represent the peer-tutoring groups. Each SME will serve as a representative for the other faculty of their cohort (e.g. the lecturer will represent all lecturers). This is important so that a large team of departmental faculty does not bog down the WBISS team. This

would create problems for decision making on the team. The primary responsibility for the SME is to provide relevant content for the WBISS team and to review all content for accuracy.

Web Author/Technician: The web author/technician will play a critical role in implementing the plan that the WBISS team creates for the web environment. This person will need to have the ability to produce the web environment and keep the WBISS team informed about the tools, technology, and resources available to the WBISS team. The web author/technician should be familiar with web programming and, if available at the institution, any knowledge or instructional management systems (i.e. WebCT, Blackboard), or any web authoring tools (i.e. Authorware, Dreamweaver) that are available to the WBISS team. The web author/technician has to be able to integrate multimedia and sound pedagogy into the WBISS. The web author/technician could come from several foreseeable communities like the Department that is developing the WBISS or from the institutions Academic Computing and Media Services.

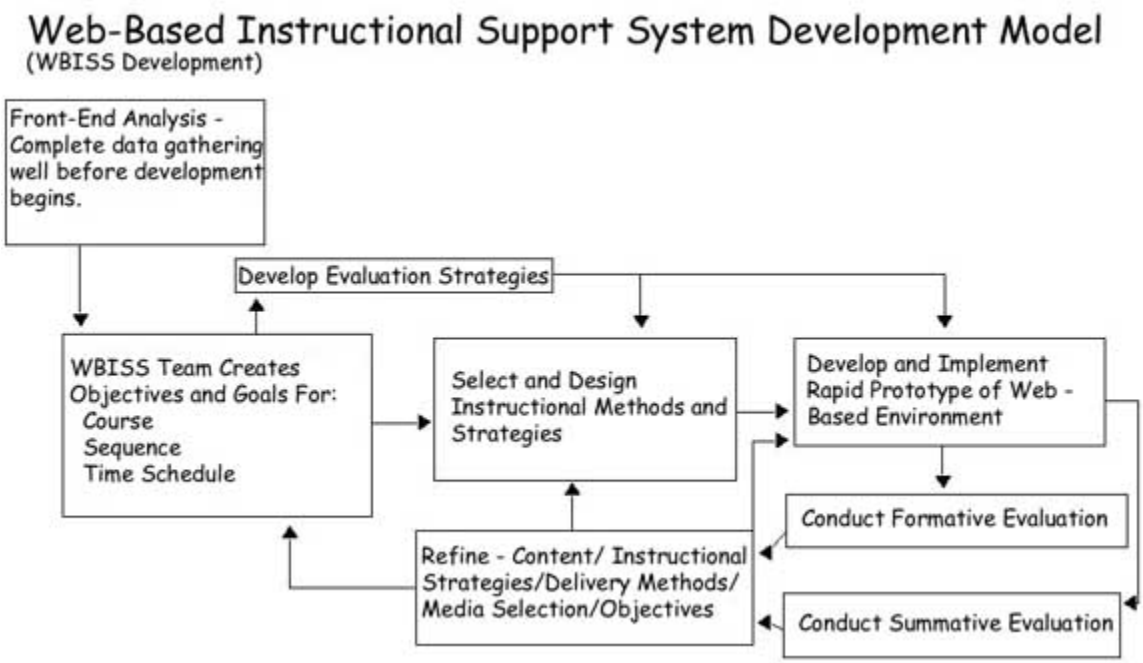
Media Specialist: This member of the team will function in a manner that is similar to the web author/technician, except that the media specialist will play a key role in implementing the multimedia portion of the WBISS. As such, this person will inform the WBISS team on the tools, technology, and resources available at the institution for the creation of multimedia like audio, video, or graphics. Many institutions already have a person those functions in this capacity for the institution. It may be possible to incorporate this individual into the WBISS team.

The primary responsibility of the media specialist will be the creation of the multimedia for the WBISS.

Instructional Developer: This is a very crucial role on the WBISS team. The developer is responsible for helping bridge the content for the WBISS with the output of the WBISS. The developer has to work to turn the objectives of the WBISS team into action. The developer has to work with the SME to develop the content for the course. The developer has to make decisions about the best methods for web-based instruction of the objectives created by the WBISS team. The developer should have a good understanding of the technology capabilities of the institution so that the developer can take full advantage of the web author/technician and the media specialist in order to deliver the most effective web-based instruction.

WBISS Manager: This position is critical in helping the WBISS team in moving foreword with the project. This position could be a person that already serves on the WBISS team in one of the other positions. The manager should not necessarily be the highest-ranking member of the team, but the manager must be effective and have leadership capabilities. The manger will be responsible for coordinating the completion of the tasks for developing the WBISS. The manager will coordinate the schedule for the team. The manager needs to understand the resources available and support and motivate the team to complete their mission.

(Table of Contents)



(Table of Contents)

The WBISS development model is based on a three-phase process. The first phase includes conducting a front-end analysis, developing goals and objectives, and developing evaluation strategies. The second phase includes selecting and designing message and media, and development of the rapid prototype. The final phase includes various evaluation procedures and a refining process. The time sequence for completion of the model is listed in figure 2 below.

	Phase 1	**Phase 2**	**Phase 3**
Activities to complete	- Front-end analysis - Develop goals and objectives - Develop Evaluation strategies	- Select message and media - Develop rapid prototype of WBISS	- Evaluate rapid prototype - Make necessary revisions
Time for completion	Complete well in advance of planned WBISS implementation.	Complete based on the schedule of the course. Implement a prototype that corresponds with lessons, units, or modules.	Complete evaluations immediately after implementation of the rapid prototype.

Figure 2 *– Time schedule for WBISS Development Model*

Several models or examples of Web-Based Instructional Support Systems exist in the literature (Lee and Owens, 2000, Cennamo, et al., 2002, Bi, 2000, Hartog, de Gooijer, van der Schaff, and Vonder, 2000, Jones and Liu, 2001, and Dijkstra, et al., 1999). Many of these models and examples provide good examples of general principles that would be involved with course-support environments, but none provide a clear path to completing a rapid prototyping process. This model attempts to lay down a framework for rapid development of the WBISS.

Front-End Analysis *(Table of Contents)*

The front-end analysis is crucial for the implementation of this model. Most rapid prototyping models are based on many iterations of evaluation in order to make the message and media as good as they possible can be. An example of this can be seen in the Dorsey, Goodrum, and Schwen Model (Gustafson and Branch, 2002). This model provides the user with no front-end step; clarification of message and media comes through the iteration process. One main goal of the WBISS development model is to create a working rapid prototype. Although there is some amount of iteration of refinement possible, the purpose would be better served with a solid front-end analysis.

The front-end analysis should be designed to gather two sorts of important data. The first information that is important to collect comes from a needs assessment. A needs assessment is conducted in order to determine what gaps exist between what is a desired outcome and what is the actual outcome. The second important data set will consist of a program/institutional analysis. This information should include data from learner

analysis, technology and media analysis, situational analysis, content and objective analysis, and extant data analysis.

The needs assessment is completed by identifying the "ideal" situation and comparing that to the present situation. There are several ways to answer this question. In one case, the user could conduct a goals analysis of the faculty involved in the course. By comparing extant data, like student grades, course evaluations, and viewing old tests, quizzes and paper, the user could determine what gaps exist between desired outcomes of the course and the current situation. This information serves as a basis for making decisions about the message and media design for the WBISS. The needs assessment might show that there are some areas that are more deserving than others of a spot in the WBISS. The needs assessment should show what content or which process skills require more personalized attention that can be given in the web-based environment.

The program/institutional analysis is important for predicting problems, identifying technology, defining objectives, creating the content for the WBISS, and identifying potential blockers and barriers that might prevent implementation. After the gaps have been identified and the specific needs are understood better, analyses must take place. Some research shows that understanding the characteristics of the learners is crucial to designing a good web-based environment (Dijkstra, et al., 1999, Cennamo, et al., 2002, Jones and Liu, 2001, Bi, 2000, Hartog, et al., 2000). Various forms of hypermedia may work better at conveying certain messages, the web can increase motivation, and learners can provide information on how to individualize the WBISS in order to meet their goals better. Several forms of analysis are required in order to

complete the program/institutional analysis. These analyses have been listed below in figure 3.

Type of Program/Institutional Analysis	***Purpose***
Learner Analysis	Learner analysis will help the WBISS team to understand the "client" in the classroom. Various methods of analysis should focus on the answering how the WBISS will help specific learners in their course performance. Learner analysis will also help to identify types of students that might require help with prerequisite knowledge or skills either in the content area or with the web-based instruction.
Technology/Media Analysis	This is an important process for the Web Author and Media Specialist. This step will highlight the various technologies and media capabilities. The team has to fully understand the technology capabilities at hand and use the institutionally provided resources to the maximum. This analysis should focus on hardware, firmware, media production capabilities, intellectual rights issues, and institutional training and support for technology.
Situational Analysis	This is an important type of analysis that tries to identify possible barriers to the use and implementation of the WBISS. The WBISS team has to look at what types of organizational, environmental, and technological factors could impede the implementation of the WBISS.
Content and Objective Analysis	Content and objective analysis should include another round of goals analysis (first round from the needs assessment). The goal of the content and objectives analysis is to start creating the framework for message for the WBISS. Content and objectives have to be examined based on the content and objectives of the actual course. Next, the content and objectives should be analyzed in order to increase their effectiveness in the web-based environment. Additionally, content analysis should be compared to learner analysis in order to determine what content would be best suited for individualized attention in the web-based environment.
Extant data analysis	This is another method for identifying and correlating content with student achievement. This analysis may help answer questions about what content will need extra attention, what content could be individualized?

Figure 3 *– Components of Program/Institutional Analysis*

The results of a careful and thorough front-end analysis will lead to an informative planning and design for implementation of the WBISS. The gaps identified by the needs assessment and the issues raised in the program/institutional analysis will be used to create the objectives for the WBISS.

WBISS Team Creates Goals and Objectives (Table of Contents)

Another process that must occur well before the implementation of the WBISS is the creation of the objectives for the WBISS. This step involves transforming the educational needs that were identified by the front-end analysis into viable and measurable educational objectives. The educational objectives drive the instructional methodologies. In addition, the educational objectives inform the process of learner assessment and, perhaps more importantly for this model, the objectives provide the backbone for the evaluation of the instructional plan. Evaluation of the product should address whether the educational objectives are completed. Much has already been written about the formation of specific objectives (For some references please see Appendix 7).

The WBISS team must write educational objectives based on several layers of emerging clarification. It is important for the team to be able to prepare objectives based specifically on the course content that will be served especially well in the web-based environment. That is to say, the WBISS objectives should reflect the overall course objectives, but the WBISS objectives should be a special subset of the overall course goals that helps to fill the potential gaps created by large class instruction (see Figure 1 and Appendix 3). The first level of clarification for the WBISS team is the overall goals of the WBISS. All subsets of goals under the WBISS objectives must relate back to the goals of the WBISS. The further levels of objective clarification are illustrated in Figure 4.

Level of Clarification	***Description***
WBISS Objectives	These objectives will serve as the overall mission plan for the WBISS. These objectives should be closely related to overall goals and objectives for the course. These objectives will be general and should help in forming the summative and formative evaluation for the WBISS project. This level of objectives should also contain the major themes for the course and WBISS.
Unit or Module Objectives	These objectives serve to link content in a specific unit to the main themes for the course. These objectives are more specific and should help inform the learner assessment.
Lesson or Tutorial Objectives	This is the most specific level objective writing. These objectives provide the specific direction for the selection of instructional methods. Additionally, for the WBISS model, these objectives drive selection of the media that is best suited for delivering the selected instructional method.

Figure 4 *– Levels of Clarification for the Writing of Educational Objectives*

One last consideration that the WBISS team has to consider during the writing of educational objectives is the schedule for the development of the course. The WBISS team has to write objectives for the team to follow for the development course. IN order for the WBISS team to be effective, they must adhere to the time related objectives that are created. These objectives will allow the team to keep on schedule. These objectives will also help the WBISS team evaluate the effectiveness of their development and implementation schedule.

Define Evaluation Strategies *(Table of Contents)*

After the objectives are written, the WBISS team has to decide on evaluation procedures. Evaluation must occur at every step in the development process after the objectives has been written. The evaluation will take different forms depending on the portion of the plan being evaluated. The evaluation needs to examine several different aspects of the implementation plan. How does the instruction relate to the levels of clarification of the objectives? What is the best media for the message? Does the

instruction meet the goals for the WBISS? How does this instruction meet the educational needs and fill the gaps identified in the front-end analysis. These questions are a sampling of the types of evaluation that the WBISS team should be looking to complete.

Select and Design Instructional Methods and Strategies (Table of Contents)

The content analysis should have identified the content areas that could effectively be implemented on the WBISS. Based on the type of content information that that is to be presented, there are certain delivery methods (Morrison, Ross, and Kemp, 2001) that may work best (see Figure 5). What is important to this model is that the instructional method will need to be adapted in order to be delivered over the web. This means that delivery methods like tutorials, simulations, and web quests may all work very well. These delivery methods may also be helpful as they increase a student's individualized experience in the course.

Type of Content	Content Definition	Instructional Strategy
Fact	An association between two things.	**Examples** → *Lecture, Demonstration*
Concept	A category that groups similar ideas or things in order to organize them.	**Integration** – Name, define, and give best example of concept. Identify other examples of concept. → *Lecture, Demonstration, Simulation* **Organizational** - Name, define, and give best example of concept. List characteristics of other examples of concept. → *Lecture, Demonstration, Discussion*
Procedure	Sequence of steps.	*Demonstration* **Organization** → *Lecture, Simulation* **Elaboration** → *Interaction, Discussion* *Practice*

Figure 5 *– Several examples of instructional strategies based on types of content. Based on Morrison, Ross, and Kemp (2001).*

Other instructional methods that do not work in a large class may also benefit from the treatment that they could receive in the WBISS. One example would be group discussion. Figure 6 displays several instructional methods and how they might best be

adapted for use in a web-based environment. It would be nearly impossible to conduct a group discussion on the bioethics of genetic research in a college classroom that has a population of 150 students. The WBISS could offer smaller groups of that same class to have the discussion. The class could be broken down into smaller groups of 20-25 students. The smaller groups could have moderated discussions outside of class time in either a synchronous (chat room) or asynchronous environment (discussion posting boards). This allows the faculty in charge of the course the ability to assess transfer of basic science knowledge into real world applications, one of the major goals of the Society for College Science Teachers (Siebert, et al., 1997, see also Appendix 1). Additionally, selection of good delivery methods allows the WBISS team to create and assess problem-solving abilities on a much more individualized manner that a large class would allow.

Instructional Method	Web-Based Delivery	Extensions of This Method
Lecture	- PowerPoint - Audio/Video Samples - HTML	- Demonstrations - Explorations - Group Interactions
Interaction	- Guided Questions - Tutorials	- Demonstrations - Explorations - Group Interactions - Collaboration
Discussion	- Chat Rooms - Message Boards	- Explorations - Interactions (personal and public) - Collaboration
Demonstrations	- PowerPoint - Audio/Video Samples - HTML - Downloadable Software - Tutorials - Java Programming	- Explorations - Interaction - Tutorials - Discussion - Collaboration
Guided Learning	- HTML - Audio/Visual Samples - Downloadable Software - Tutorials - Java Programming	- Explorations - Interaction - Tutorials - Discussion
Brainstorming	- Chat Rooms - Message Boards - Interactive White Boards	- Exploration - Collaboration - Interaction - Discussion
Simulations	- Tutorials - Java Programming - HTML - Downloadable Software	- Exploration - Collaboration - Interaction - Discussion

Figure 6 *– This table demonstrates potential applications of instructional strategies and their adaptations for the Internet. Selection of strategies and delivery methods will be dependant on the results of the technology analysis.*

This is also the stage when the WBISS team must make good decision about what available media will best fit with the prescribed methods. The web-based environment allows a good deal of flexibility with different forms of multimedia. It is important for the WBISS team to choose appropriate media for appropriate methods.

While the WBISS team is determining the best methods and instructional strategies for the WBISS, they also need to focus on the problem of instructional sequence. The content sequence for the WBISS should be dictated by the content

sequence for the lecture and lab sections of the course. Many methods for sequencing instruction exist (an example is provided in Figure 7 below). The WBISS team will not have to worry about sequencing content, however, some adaptations may be necessary when taking which methods should come first in the WBISS. For example, it may be impractical to start a web-based discussion before there is some sort of content presentation. This is the type of sequencing problems that the WBISS team will have to work with.

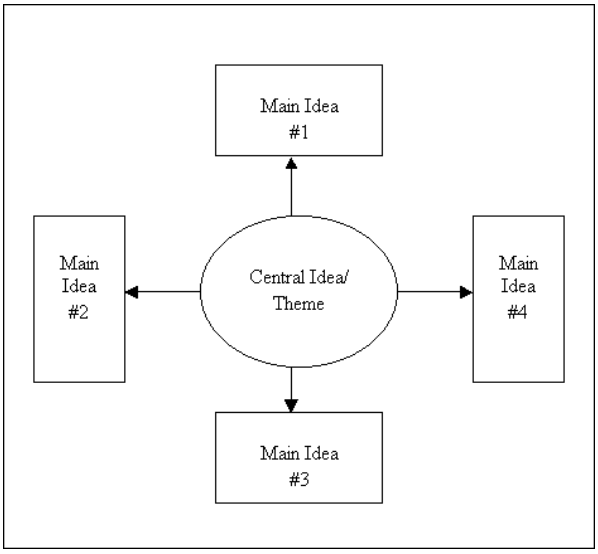


Figure 7 *– This is a sample of a content sequencing strategy based on concept mapping. This is based on Lee and Owens (2000).*

Evaluation at this stage revolves around the WBISS team and the regular course faculty examining the selection of methods and media for the presentation. It will be important for the development of the WBISS that the delivery strategies are sound. This is the last important step that should occur before the implementation of the WBISS and prior to the start of the actual course.

Develop and Implement Rapid Prototype of WBISS, Evaluate, Revise (Table of Contents)

From this point on the development of the WBISS is meant to happen shortly before the release to the students. Many of the prior steps were taken in order to make the prototyping efficient. The reason rapid prototyping was selected for this model is based on several factors: time constraints for faculty members, the time frame of the actual course, and the time of development for instructional materials. Many faculty members are busy during the summer months completing field or bench research or are busy with other endeavors. Rapid prototyping takes the pressure off of having an entire faculty available for the WBISS development. Either the WBISS can be created all at once just prior to the start of the course or individual modules can be released based on their relevance to the time frame for the course. In either case, the rapid prototyping part of the development takes place when the students use a certain module. The WBISS will include built in evaluation procedures for the modules.

All members involved in the WBISS (WBISS team, course faculty, and students) will participate in the initial evaluation of the current module. The WBISS team can determine how the evaluation should take place. For example, the WBISS team could choose to have a small group of students try the instructional materials and then evaluate them. Based on the initial evaluations, the WBISS team could make revisions and then implement the module for the entire class for a second round of evaluation. The WBISS could choose to simply implement the instructional materials to the entire class and then evaluate the efficacy of the materials. These are just two examples of how the rapid prototyping scheme could be used.

The evaluation is a continuous process. Formative evaluation of the prototype must occur and the data must be easy to analyze. This will allow for rapid decisions to make about the efficacy of an individual module. The summative component of evaluation is also important in determining long-term change options for the WBISS team to consider. The WBISS team has to consider all aspects of the WBISS when evaluation is completed. The team must look at some of the following aspects of the WBISS: usage of modules, effectiveness of remedial and new materials, student achievement, and how well the WBISS related to the course, among other things.

The desired end result of these implementation and evaluation steps is to determine what revisions should to be made within the WBISS. The WBISS team has to look at the evaluation and look to revise the current content, instructional and delivery method, and the media that is used. This evaluation data will help guide revision of current modules and should help to highlight potential changes in future modules. This revolving process of implementation and revision will help to shape an effective online learning environment.

Management Issues (Table of Contents)

An important role for the WBISS team, and more specifically, the WBISS team manager, is the consideration of the impact of revision of the WBISS on the students that may have already completed a certain module. Minor revisions of the content or strategies may have no effect on student learning. Major revisions, however, could have a large impact on the student in the course. The WBISS manager and team have to be able

to minimize the effect of a possible revision. Major revisions may need to wait for the next time the course is offered in order to be successful.

In addition, time management of the delivery and implementation of the WBISS content and modules is critical to the success of the WBISS. If the materials are constantly late in their delivery, their relevance to the course becomes diminished, as does their efficacy.

Planned Change Issues (Table of Contents)

Planned change is an important consideration when setting up a WBISS team and implementing a WBISS for a course. It will be important to convince some faculty members that the WBISS will be an effective strategy to use with a large course. Strong administrative and departmental support will be one key to helping some faculty accept the development plan. It will also be important to provide solid reasoning and background into why the WBISS will help deal with some of the issues associated with large classrooms (Appendix 2). Perhaps the department might want to start by implementing the WBISS in only one of several lectures. Positive results in a pilot study would be hard for an unsupportive faculty member to disagree with.

The selection of the WBISS team is perhaps the most important step in implementing the WBISS. If the team is not a highly motivated group of people that are dedicated to changing the current system, then success will be difficult. This is where institutional departments have to assess the cost-benefit of the creation of a WBISS. Initial creation of a WBISS may incur a large demand on the resources of a department. Effective implementation of the first WBISS will lead to reducing the issues that large

population courses create and the effort required to create or revise new or existing WBISSs in the future will be minimized.

SUMMARY (Table of Contents)

The Society for College Science Teachers has described goals for science instruction at the college level (Appendix 1). These goals call for students that are able to demonstrate basic skills of evaluation through problem solving. In large population college classrooms it can be hard to assess if students are gaining these critical skills. Gagne (1992) asserts that instruction in large groups leads to a "marked reduction in precision" for the events of instruction. It is only probable that the instructor has everyone's attention. It is only probable that all students have recalled prerequisite knowledge, and so on. Weimer (1994) provides additional challenges for large class instruction: active learning, personalized learning, diverse learning needs.

Creating a web-based instructional support system can help college faculty in addressing these problems. In creating a web-based environment that supports the traditional classroom, college instructors can provide active, personalized learning for their students. Students can work with tutorials and other delivery strategies to increase their participation, attention, and motivation. Students may be directed to recall prerequisite knowledge, or, if the students do not have the prerequisite knowledge, they can be directed to a place that allows the students to fill in that missing background.

Developing a web-based instructional support system may be resource consuming, but there are a host of benefits that can be enjoyed by the faculty and the students involved with the process.

References (Table of Contents)

Bi, X. (2000). Instructional design attributes of web-based courses. *WebNet 2000 World Conference on the WWW and Internet Proceedings* (San Antonio, TX, October 30-November 4th, 2000); 38-43.

Caprio, M.W. (1993). Cooperative learning – the jewel among motivational – teaching techniques. *Journal of College Science Teaching*, 22(5): 279-281.

Cennamo, K.S., Ross, J.D., Rogers, C.S. (2002). Evolution of a web-enhanced course: incorporating strategies for self-regulation. *Educase Quarterly*, (25)1: 28-33.

Diamond, R.W. (1998). Designing and assessing courses and curricula, a practical guide. San Francisco: Jossey-Bass Publishers.

Dick, W. (1980). Formative evaluation in instructional development. *JID*: 3(3), 3-6.

Dijkstra, S., Collins, B., Eseryel, D. (1999) *Instructional design of www-based course-support environments: from case to general principles.* In Collis, B., Oliver, R. (Eds.) Proceedings of ED-MEDIA 99: World Conference on Educational Multimedia, Hypermedia, and Telecommunications, June 19-24: 231-235.

Ebert-May, D., Brewer, C.A., Allred, S. (1997). Innovation in large lectures – teaching for active learning. *BioScience*, 47(9): 601-607.

Gagné, R.M., Briggs, L.J., Wager, W.W. (1992). Principles of instructional design. 4th Ed. Belmont, CA: Wadsworth/Thomson Learning.

Gustafson, K.L., Branch, R.M. (2002). Survey of instructional development models. 4th Ed. Syracuse, NY: ERIC Clearing House on Information and Technology.

Hartog, R.J., de Gooijer, C.D., van der Schaff, H., Vonder, O.W. (2000). Comparing web based course development with and without a learning environment. *WebNet 2000 World Conference on the WWW and Internet Proceedings* (San Antonio, TX, October 30-November 4th, 2000); 240-246.

Helford, P.Q., Lei, R.M. (1999). Using the web to deliver and enhance classes: two case studies. *Proceedings of the European University Information Systems International Conference* (5th, Espoo, Finland, June 7-9, 1999); 1-8.

Jih, H.J. (2001). Promoting interactive learning through contextual interfaces on a web-based guided discovery CAL. *Journal of Computers in Mathematics and Science Teaching*, 20(4): 367-376.

Jones, C.M., Liu, M. (2001). Web-based instruction: the effect of design considerations on learner perceptions and achievement. *ED-Media 2001 World Conference on*

Educational Multimedia, Hypermedia & Telecommunications. Proceedings (13th, Tampere, Finland, June 25-30, 2001); 835-840.

King, P., Hildreth, D. (2001). Internet courses: are they worth the effort? *Journal of College science teaching*, 31(2): 112-115.

Lambert, L.M., Tice, S.L., Featherstone, P.H. (1996). University teaching: a guide for graduate students. Syracuse, NY: Syracuse University Press.

Lee, W.W., Owens, D.L. (2000). Multimedia-based instructional design. San Francisco: Jossey-Bass Publishers.

Lumsden, A.S. (1997). The large class. In Siebert, E.D., Caprio, M.W., Lyda, C.M. (1997). Methods of effective teaching and course management for university and college science teachers. Dubuque, Iowa: Kendall/Hunt Publinshing.

Marbach-Ad, G., Seal, O., Sokolove, P. (2001). Student attitudes and recommendations on active learning. *Journal of College Science Teaching*, 30(7): 434-438.

Moore, R., Miller, I. (1996). How the use of multimedia affects student retention and learning. *Journal of College Science Teaching*, 25(4): 289-293.

Morrison, G.R., Ross, S.M., Kemp, J.E. (2001). Designing effective instruction. 3rd Ed. New York: John Wiley & Sons.

Ostiguy, N., Haffer, A. (2001). Assessing differences in instructional methods. *Journal of College Science Teaching*, 30(6): 370-374.

Riffell, S.K., Sibley, D.H. (2003). Learning online: student perceptions of a hybrid learning format. *Journal of College Science Teaching*, 32(6): 394-399.

Romiszowski, A.J. (1999). Designing instructional systems. New York, Kogan Page.

Rossett, A. (1987). Training needs assessment. Englewoods Cliffs, NJ: Educational Technologies Publications.

Siebert, E.D., Caprio, M.W., Lyda, C.M. (1997). Methods of effective teaching and course management for university and college science teachers. Dubuque, Iowa: Kendall/Hunt Publinshing.

Toth, L.S., Montagna, L.G. (2002). Class size and achievement in higher education: a summary of current research. *College Student Journal*, 26(2): 253-260.

Weimer, M. (1994). Facing the challenges of the big class. The Teaching Professor, February: 1.

Zhao, Y. (1998). Design for adoption; the development of an integrated web-based education environment. *Journal of Research in Computing in Education*, 30(3): 307-328.

Appendix 1 – Goals of the Society for College Science Teachers (from Siebert, et al 1997) (Table of Contents)

- Use the language and concepts of science appropriately and effectively in written and oral communication.

- Use the methodologies and models of science to select, define, solve, and evaluate problems independently and collaboratively.

- Adequately design, conduct, communicate, and evaluate relatively basic but meaningful experiences.

- Make scientifically based decisions and solve problems drawing on concepts and experiences from relevant areas.

- Evaluate critically: evidence, interpretation, results, and solutions related to the course content within a real life context.

- Explain scientifically related knowledge claims as products of scientific inquiry process that, while diverse in scope, conforms to the principles of logical reasoning.

- Demonstrate research skills necessary to access needed data to support scientific inquiry.

- Ask meaningful questions about real world scientific issues and conundrums.

Appendix 2 (Table of Contents)

Major Challenges for Large Class Instruction

Adapted from Maryellen Weimer, 1994.

1. Make learning active.
2. Personalize the class.
3. Work with diverse learning needs and preparation levels.
4. Manage disruptive behavior.
5. Assess learning.
6. Adapt teaching style to the "stage."
7. Enjoy teaching large classes on a long-term basis.

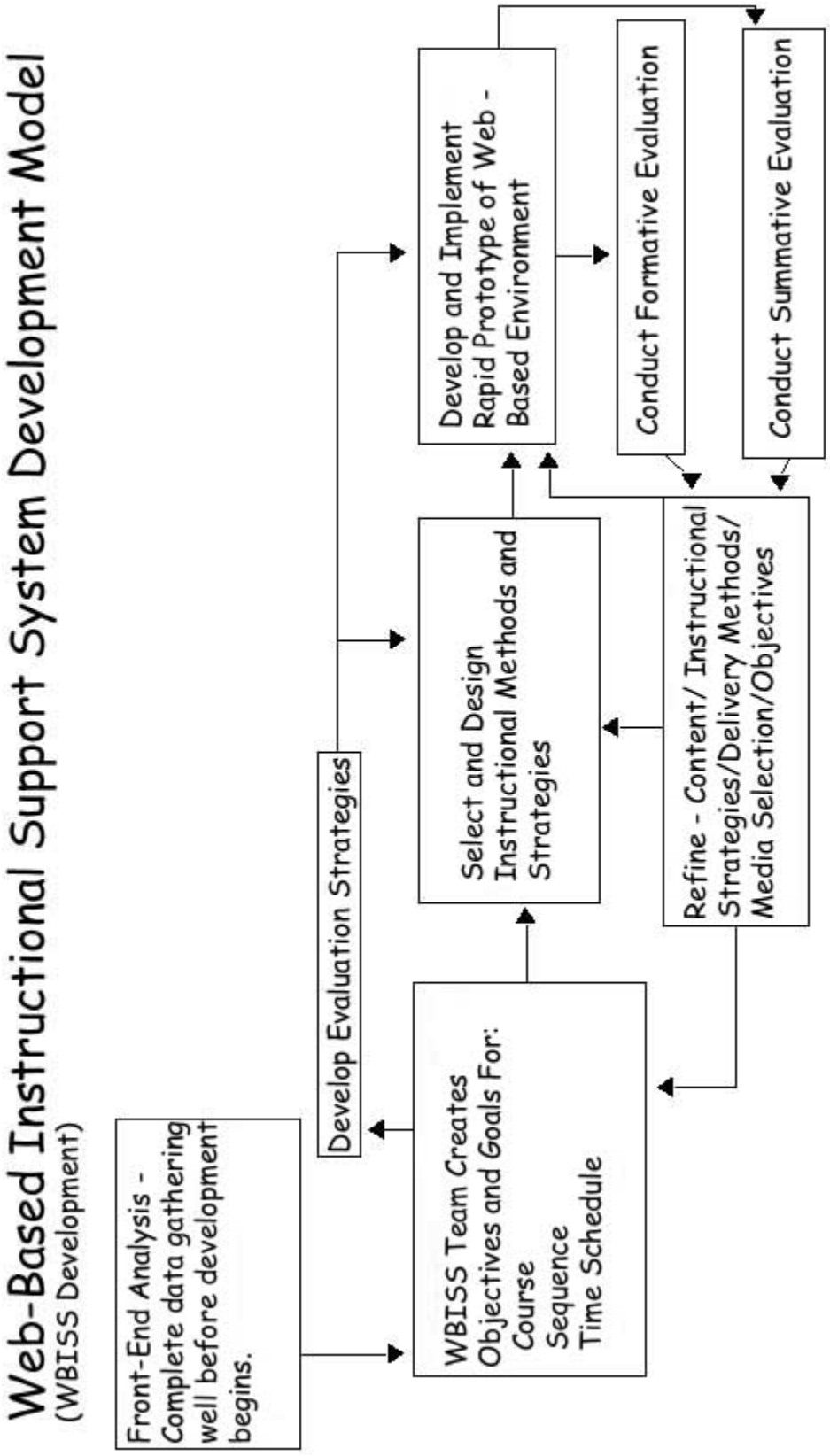
Appendix 3 – Potential Gaps Created by Large Class Instruction (Table of Contents)

Potential Gap	How WBISS will help to address Gap
Learning is not active.	Students can work interactively with the hypermedia on the WBISS and increase their active participation in a course.
Class is less personalized.	Students can work in a hyperlink rich environment and meet their own educational needs as they are suited to their educational field.
Work with diverse learning needs and preparation levels.	As above, students can work in a rich hyperlink environment. In addition, students that lack an educational background in a topic can be directed to supplemental tutorials that are directed by the course needs instead of general tutorials that might be found in textbooks or generalized course supplements.
Assessment of learning.	Online assessment, both for practice and credit, can provide students with immediate feedback about their learning.
Lack of communication.	An online environment could allow for rapid communication with instructors outside of normal office and operating hours. Additionally, bulletin boards and chat rooms would allow students the ability to ask questions of instructors or other students either synchronously or asynchronously. This also allows groups to meet and plan without physical meeting places. Additionally, answered questions are documented for later retrieval.

Appendix 4 - Roles and Responsibilities on the WBISS Team (Table of Contents)

Role	***Responsibilities***
Subject Matter Expert (SME)	- Develop and select the content for the WBISS. - Evaluate the content after WBISS creation.
Web Author/Technician	- Design and develop web environment. - Publish and maintain the web environment. - Inform the WBISS team of technology resources available to the team. - Integrate multimedia into the web environment. - Have advanced knowledge of the authoring tools available, including knowledge or instructional management tools.
Media Specialist	- Produce audio, video, or graphics for the WBISS. - Inform the WBISS team about the technology available to the team. - Integrate multimedia into the web environment.
Instructional Developer	- Manage content. - Help to develop WBISS instructional goals. - Select instructional interventions. - Develop instructional materials. - Work with the web author/technician and media specialist to design the web environment. - Help the WBISS team make effective decisions about the project.
WBISS Manager	- Manage the completion of the project. - Create and maintain development schedule. - Manage resources. - Maintains team productivity. - Supports and motivates the team. - Resolves conflicts.

Appendix 5 - WBISS Development Model (Table of Contents)



Appendix 6 – Front-End Analysis Plan (Table of Contents)

Needs Assessment Component	
Needs Assessment	The needs assessment will focus on identifying current and ideal situations for the academic course in which a WBISS will be implemented. The goal for this front-end component is to identify the gaps between the current and ideal situations that are educationally relevant concerning the development of the WBISS.
Program/Institutional Analysis Component	
Type of Analysis	***Purpose***
Learner Analysis	Learner analysis will help the WBISS team to understand the "client" in the classroom. Various methods of analysis should focus on the answering how the WBISS will help specific learners in their course performance. Learner analysis will also help to identify types of students that might require help with prerequisite knowledge or skills either in the content area or with the web-based instruction.
Technology/Media Analysis	This is an important process for the Web Author and Media Specialist. This step will highlight the various technologies and media capabilities. The team has to fully understand the technology capabilities at hand and use the institutionally provided resources to the maximum. This analysis should focus on hardware, firmware, media production capabilities, intellectual rights issues, and institutional training and support for technology.
Situational Analysis	This is an important type of analysis that tries to identify possible barriers to the use and implementation of the WBISS. The WBISS team has to look at what types of organizational, environmental, and technological factors could impede the implementation of the WBISS.
Content and Objective Analysis	Content and objective analysis should include another round of goals analysis (first round from the needs assessment). The goal of the content and objectives analysis is to start creating the framework for message for the WBISS. Content and objectives have to be examined based on the content and objectives of the actual course. Next, the content and objectives should be analyzed in order to increase their effectiveness in the web-based environment. Additionally, content analysis should be compared to learner analysis in order to determine what content would be best suited for individualized attention in the web-based environment.
Extant data analysis	This is another method for identifying and correlating content with student achievement. This analysis may help answer questions about what content will need extra attention, what content could be individualized?

Appendix 7 – References for Writing Educational Objectives (Table of Contents)

Anderson, L.W., Krathwohl, D.R. (2000). Taxonomy for learning, teaching, and assessing: a revision of Bloom's taxonomy of educational objectives. Longman.

Diamond, R.W. (1998). Designing and assessing courses and curricula, a practical guide. San Francisco: Jossey-Bass Publishers.

Forshay, W.R., Silber, K.H., Stelnicki, M.B. (2003). Writing training materials that work, how to train anyone to do anything. New York, Jossey-Bass/Pfiffer.

Gagné, R.M., Briggs, L.J., Wager, W.W. (1992). Principles of instructional design. 4th Ed. Belmont, CA: Wadsworth/Thomson Learning.

Lee, W.W., Owens, D.L. (2000). Multimedia-based instructional design. San Francisco: Jossey-Bass Publishers.

Morrison, G.R., Ross, S.M., Kemp, J.E. (2001). Designing effective instruction. 3rd Ed. New York: John Wiley & Sons.

Romiszowski, A.J. (1999). Designing instructional systems. New York, Kogan Page.