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INTEGRATING WEB-BASED INSTRUCTION AND CLASSROOM TEACHING: CASE STUDIES FROM THE CARIBBEAN

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Abstract
This paper describes an integrated instructional model for integrating web-based instruction and classroom teaching in educational institutions in the Caribbean. Two studies are presented: one, a 1-semester Computer Science course for students at university level and the other, a 2-year course in Information Technology designed for secondary school students across the Caribbean. In each case, web-based and classroom teaching are woven into each other seamlessly throughout the period of instruction to form an integrated instructional system. The studies show that the integrated approach facilitated more effective learning. At university level, teaching emphasis changed from delivery of content to one of facilitating and guiding the learning process. The lecturer's knowledge of the subject area remained of critical importance to the learning outcome. Students took more responsibility for their own learning and for monitoring their own progress. Teaching methods at secondary schools in the Caribbean are largely traditional, classroom teaching. With the integrated approach to teaching, the learning environment more readily caters for all levels of children within a class, allowing the teacher to provide more individual attention to students. The web course design has to be specially tailored to the student age group and the school environment

Key Words
Web-based Instruction, Hybrid Instruction, Blended Learning, Instructional design, Caribbean Education, Computer Science Course.

1. Introduction

The many educational challenges facing countries of the Caribbean are similar to those of small nation states around the world. These include issues of scale, isolation and dependence [1]. The development of distance education is one of the strategies devised in response to these challenges. Distance education in the Caribbean has focused mainly on tertiary and adult learning. The University of the West Indies (UWI) has been the major institution through which distance education has been delivered. The UWI is a regional university serving sixteen Caribbean countries (the English–speaking Caribbean). It is a dual mode university offering traditional face-to-face programs as well as distance programs. The prevailing trend in dual mode institutions, as is the case with UWI, is to keep face-to-face and distance offerings separate and distinct. Morgan [2] argues the case for combining distance and face-to-face teaching strategies to enrich the range and effectiveness of tertiary education offerings at UWI.

Several authors have examined various mixes of computer-based instruction and face-to-face instruction. Tuckman [3] refers to a 'hybrid' instructional model which combines features of traditional classroom instruction and those unique to computer-based instruction. He notes that 'the critical element in technology enhanced instruction is the nature of the instructional model, in particular, the extent to which it incorporates the unique advantages of the technology rather than simply mirroring that of conventionally taught courses'. Young [4] explores how some universities are using hybrid teaching to bridge the gap between traditional and online instruction. The level of integration of instruction in hybrid courses varies; Lago [5] and Leh [6] report on mixed-mode hybrid courses which use classroom instruction part of the time and web-based instruction part of the time. The term 'blended learning' is used as an umbrella concept to encompass a variety of mixed modalities of learning [7, 8].

This paper describes an integrated instructional model demonstrated in two case studies, one a Computer Science course at a university campus and the other an Information Technology course taught at secondary schools. In each case, web-based and classroom teaching are woven into each other seamlessly throughout the period of instruction to form an integrated instructional system. The characteristics of the student population and the education environment are different in these two cases; instructional design must therefore be tailored to its context.

The first study examines a 1-semester course for final year students in the B.Sc. Computer Science program at The University of the West Indies. The students registered for this course (96 students) represents a small closed group. They are generally more mature and self-disciplined than the students in the second study and are more capable of independent study and self learning.

The second study is a 2-year course designed for secondary school students across the Caribbean [9]. This is a course in Information Technology which prepares students for a regional exam examined by the Caribbean Examination Council (CXC). Approximately 8000 students take this exam annually. The target student group here is much larger and they are spread over a wide geographic region. The students are younger and the teacher is central to learning with this group. Now, most of the attention to distance learning in the Caribbean has been given to tertiary and adult learners. Little attention has been paid to secondary level. This study breaks new ground and provides a workable approach for integrating web based education into mainstream education in the secondary school system.

The remainder of this paper is organized as follows. First, in Section 2, we overview the educational system in the Caribbean to provide the context of the two courses. Section 3 describes the integrated instructional model as it applies to the campus-based course and discusses the results and the experience of this approach. In Section 4, we focus on the course for secondary school students. We first discuss the instructional design used in this web course as this course consisted of modules requiring different pedagogical approaches. We describe the mechanism for integrating the web-based and face-to-face instruction and give teachers' and students' ratings on different aspects of teaching and learning.

2. The Education System in the Caribbean

The University of the West Indies is a regional University serving countries widely separated by water. There are three main campuses in Jamaica, Trinidad and Tobago, and Barbados as well as University Centers in all member countries. The traditional face-to-face mode of teaching and learning has been used from its inception in 1948. In 1983, UWI formally began offering distance education courses using audio teleconferencing and print materials. This has expanded over the years; today UWI is a dual mode institution offering distance and face-to-face programs as parallel or mixed programs. While much of the distance delivery mode remains print based and teleconferencing, some recent distance programs are web-based. The University has acquired course authoring and management software and through the Instructional Development Unit has provided resources and training to facilitate a broader range of teaching strategies in the classroom, including technology enhanced instruction. An integrated approach using both web based and face-to-face teaching, as is discussed in case study 1 , fits in well with the university's strategic direction and vision to increase access to education and improve the quality of education for all Caribbean people.

The education system in the Caribbean is a three-tiered system namely primary, secondary and tertiary level. Students of secondary schools generally age 11-18 years. They follow a program of study for five years, Forms 1-5, in which they acquire a broad general education. A small number of these students continue their education in secondary school, completing two more years, Forms Lower 6 and Upper 6, in which they specialize in two or three subject areas before perhaps moving on to tertiary level (University/College). Teaching at secondary schools is almost completely traditional, blackboard and chalk mode.

At the end of Form 5, students across the Caribbean take a common set of exams in the various subject areas. These exams are administered by a regional examining body, the Caribbean Examination Council (CXC). A CXC Secondary Education Certificate is awarded to successful candidates. One of the subjects offered and examined by CXC is Information Technology [10]. Each school that offers this subject is required to have an appropriate number of computers and Internet access available to its IT students. Computer laboratories are in place at many Caribbean secondary schools but there is a shortage of qualified IT teachers. As in many other countries, the demand for Computer Science graduates is high. All governments of the region have recognized the need to raise the level of IT skills of its people. The CXC IT course, which is the subject of the second case study in this paper, plays an important role in achieving that goal. Secondary schools have a long tradition of face-to-face teaching; most teachers have little experience with distance education. The trend in schools is to provide computer labs for computer literacy and Internet access and for teaching Information Technology. Some experimentation has been done with prepackaged software on CD. The transition to technology based education may possibly have its greatest chance of success starting with the teaching of IT.

3. Case Study 1: Integrated Instructional Model - University Level

While technology has played a major role in distance education, its role in campus-based instruction has been minor by comparison [3]. This is certainly true at The University of the West Indies. The B.Sc. Computer Science program at UWI is taught as a face-to-face program using traditional classroom lectures and computer laboratory sessions. Standard presentation aids such as whiteboard, slides and Power Point presentations are used. During 2002, one course within that program, CS35A Database Management Systems, was offered for the first time using an integrated approach combining face-to-face and web-based teaching. The web course was developed in WebCT course management software.

3.1 Course Design and the Integrated Instructional Model

The CS35A DBMS course is a final year course for computer science majors. The course covers the design,

implementation and management of Database Systems that would enable the IT professional to organize and manage corporate data to support the business activities of the organization. The course has a computer lab component in which students gain hands-on experience in Oracle DBMS. There is a short syllabus for the course in the University's catalog of courses but the lecturer has a lot of flexibility in the depth of coverage of the various topics. In the design of the web-based course, the course content was divided into six modules each containing a number of related topics. The content contained a good balance of descriptive material, drawings and images, and short exercises/activities. Links to resource material and online tutorials were incorporated into the content. The web course contained a variety of assessment opportunities, both formative and summative. Study tools and communication facilities were provided. Apart from the web course, a printed text book was also recommended for the course.

In the traditional instructional mode for the course, the class schedule would normally consist of five contact hours per week with the lecturer/tutor: three 1-hour lectures and one 2-hour lab. Occasionally, one of the lecture hours would be conducted as a tutorial. In the integrated instructional mode of the study, no changes were made to the conduct of the lab sessions; the 2-hour lab sessions continued to be conducted face-to-face in the computer lab, with the lecturer or tutor guiding the class through a sequence of tasks. The lab sheets were made available to students via the web course, a few days ahead of the lab session. All lab sheets were not made available at the start of the course as lab sheets sometimes had to be adjusted to cater for the speed of the class or even because some technical problem (hardware/software/network)may have affected a previous lab session. Each week two 1-hour classes were scheduled for classroom 'lectures'. Students were required to study the current topic using the web course, prior to coming class. A very detailed schedule was provided at the beginning of the course so that students always knew where they were and what was expected of them. A printer friendly 'notes' version of the topic was included in the web course; students printed these, brought them to class and made their own handwritten notes on them.

In the classroom lectures, students were no longer passive receivers of information. The lectures were very interactive; they became discussion of course material where students were able to make real contributions to the discussion. Often the lecturer would introduce new examples and cases introduced to supplement and reinforce what was in the web course. Very little time in class was spent on presenting straightforward factual information such as definition of terms (what is sometimes called 'book learning'); rather, time was devoted to problem solving activities such as design and modeling of database solutions.

At the end of each topic, students were given the opportunity to assess themselves in a non intimidating manner. A quiz/self test was developed for each topic and students had three attempts at each quiz which were automatically graded. Each test had a window of time during which it would be available. Students could access their own scores. The highest score was carried forward in the student profile. These scores did not contribute to the formal coursework assessment which is included in the final mark that the student earns for the course. Nonetheless, the self tests were challenging to the students and helped them to monitor their own progress. The lecturer could also access student scores and monitor student progress.

Additional study tools/facilities that were included in the web-based course included past exam papers and essay type tutorial sheets. The tutorial problems were discussed in class. The communication facilities included email, discussion board, and chat room. The discussion board provided a forum for students to participate in the class on-line. Participation was voluntary and was not graded. Assessment consisted of three written assignments, a lab practical and a final 2-hour written exam. This was exactly the same as was done in the traditional offering of the course. The assignments and exam were essay type problem sets that were marked by the lecturer/tutor.

3.2 Results and Discussion

The final results of students in the course justified all the effort put into developing and offering the web based course integrated with classroom teaching. The pass rate was 96%, the highest ever recorded for that course. Table 1 shows a comparison of results for the past three offerings of the course which were taught by the same lecturer.

Year	Number of Students	Pass Rate	Number of "A" Grades
2000	72	86 %	13
2001	116	82 %	12
2002	96	96 %	21

Table 1. Performance Statistics for the course CS35A

With the integrated approach, not only was the overall pass rate higher than in previous years, but the grades that students received for the course were higher. A significantly larger number of students attained grade A^- or higher for the course. Students enjoyed the course and gave positive feedback about the mode of delivery. The academic standard of the course was not compromised; rather the approach facilitated more effective learning.

We conclude this section with some further comments on the model based on the lecturer's reflections and observations:

The style and format of the classroom activities more easily facilitated real learning. The lectures were not focused as much on presenting content; rather, the classroom became an environment where the lecturer could help the students build a deeper understanding of material that they had already read. Learning took place *in the classroom*. Often, in the traditional approach, course content is presented in the classroom, students take notes and digest and assimilate the content later in their own study time *outside the classroom*.

The role of the lecturer was not diminished. The lecturer's experience and knowledge of the subject were crucial to the success of the model. This knowledge was required to be able to teach the subject, to direct the discussion, to respond to student questions, and to be able to determine the depth and extent of coverage of the topics within the modules of the course.

With traditional teaching students are often given handouts to read or tutorials to prepare before coming to class. The experience of many lectures is that often students do not attempt the tutorials or read the material and expect that in the tutorial class they would be 'spoon fed' the answers. The experience with this on-line course was very different. Students were excited about the course and the mode of delivery. Students found the presentation of content stimulating; they read the designated material or attempted the exercises before coming to class. This attitude was encouraged by discussing with them the need for them to take responsibility for their own learning since the virtual classroom requires mature learners who are self-disciplined.

The feedback from students indicated that the self tests were very helpful. Students attempted most of the self tests. They liked the idea that they had several attempts at each test so that they were not discouraged by their first attempt. They felt that the self tests helped them to master the course in small 'chunks' throughout the semester so that they did not have the usual last minute rush before final exams. From the course designer perspective, creating the self tests was probably the most challenging part of creating the web course.

4. Case Study 2: Integrated Instructional Model - Secondary Level

This second case study examines an integrated approach to teaching one subject, Information Technology, at the secondary school level. Generally, the course of study for CXC IT is conducted over a 2-year period (Forms 4 and 5) culminating in a final exam for CXC certification. The CXC IT syllabus consists of two proficiencies, 'General' and 'Technical'. Technical proficiency focuses on computer fundamentals and productivity tools that include word processing, spreadsheet, and database management aimed at preparing the student for jobs at the pre-technician level. General Proficiency focuses on computer fundamentals, data processing and programming. The latter provides the requisite skills and knowledge for students wishing to pursue higher academic qualifications. The syllabus for this course is set by CXC (and updated periodically); the syllabus is well defined and it does not allow for flexibility of course content as with the tertiary level course described in case 1.

A Web-based course, WebIT, was developed for teaching IT at secondary schools. It was implemented, in test mode, at some selected schools. The course was developed using Learning Space course management software. The course was designed to complement classroom teaching. The teacher plays the role of facilitator rather than a dispenser of instruction. This in keeping with resource-based theories of learning styles, 'teachers become guides in the process of discovering learning, rather than functioning as the sole content experts' [11]. In the remainder of this section of the paper we first discuss the instructional design approach used in the WebIT course. Following this we describe the way in which the integration of web-based and face-to-face instruction was accomplished and give the perceptions and attitudes of teachers and students to this approach to teaching and learning

4.1 Course Design: Designing for Different Pedagogical Approaches

Grabe [12] contends that much of the technology based instruction has focused on the acquisition of factual information rather than on higher order thinking and problem solving. The course chosen for this study provides the opportunity for technology based instruction to be applied to different types of learning. Analysis of the CXC IT syllabus revealed three types of units: concept based, skill based, and problem based learning.

The concept based learning units of the syllabus are *Fundamentals of Hardware and Software,* and *Applications and Implications*. They contain descriptive instructional materials that require the student to understand the terms and concepts. Evaluation is mainly testing understanding and memorization. At these levels the students are expected to remember the instructional materials, and to grasp the meaning and explain them. In the WebIT course, concept-based instruction focused on presenting factual information and engaging the student in a variety of performance activities related to the specific subject matter being taught. Assessment was mainly subjective analysis of participants' writing. Concept based learning units lend themselves to students who learn best by reading and prefer processing information primarily through sight. They have their foundation in cognitive theories of learning styles. In concept based learning, the computer is used as a **T**utor.

The skill based learning units of the syllabus are *Productivity Tools, Word Processing*, *Spreadsheet*, and *Database Management*. The unit on productivity tools includes word processing, spreadsheet, and database management at the introductory level and is designed for the students taking the General Proficiency. The skills learnt at this level are further developed and enhanced when these tools are treated as individual units, for students taking the Technical Proficiency. These units are intended to produce skill based learning outcomes. Emphasis is on usage and familiarity with the software. These units are learned by doing. Instructional design of these units was based on behavioral learning theory incorporating repetition and feedback [13]. The teaching of the skills-based units (productivity tools) using the web course emphasized hands-on experience. After explaining some functionality of the tool, students were given sets of tasks to complete. A launch button within WebIT launched the application software so that movement between WebIT and the productivity tool was seamless. Exercises were example driven with immediate feedback. Students could also submit completed work for review and feedback from the teacher. The web course was particularly successful in teaching the skills-based units of the course. In skill based learning, the computer is used as a **T**ool.

The problem based learning units of the syllabus are *Introduction to Programming*, *Information Processing*, and *Programming*. These are problem based requiring analytical skills in problem solving, algorithm development and programming. Students are required to apply and use the knowledge to solve programming problems, and to perform critical thinking activities such as analyzing and evaluating. For example, critical thinking is performed when students select the best solution from alternatives during algorithm development. Additionally, creative thinking is performed during programming. These kinds of higher-order thinking activities are emphasized for supporting learning in constructivist learning environments [14]. The Information Processing and Programming units are taken only by students preparing for General Proficiency. The number of students taking the General Proficiency has not grown significantly over the past few years, whereas the numbers for the Technical Proficiency has grown by 500% in the past five years [10]. From a survey conducted in several islands of the Caribbean [9], one of the main reasons for this low enrollment in the General Proficiency is difficulty with the programming that is required. The web course was designed to teach programming in a more interactive manner than the traditional textbook. Students could actually run the code being presented in the exercises and see the effect immediately or students could be required to complete some block of code or debug some procedure presented. Hints were presented in an interactive manner. This made for attractive and stimulating programming for students at the secondary level. In addition, a framework/structure for students to develop complete modules could be accomplished through the problem-based learning approach. The teacher provided assistance and guidance in nurturing problem solving skills. In this approach group work was also encouraged. The approach to teaching programming was algorithm development before coding. Examples used to illustrate algorithm development were presented in order of difficulty. It is important that students recognize the need for good and sound planning of solution before embarking on coding. In problem based learning, the computer is used as a **T**rainee.

4.2 Integrating Web-based and Face-to-face Instruction

Before developing the course, an initial survey was conducted among secondary schools in Grenada, Trinidad &Tobago, and Barbados to determine schools readiness for web-based education as well to gain an understanding of the existing instructional characteristics. Schools generally had the necessary infrastructure to be able to introduce the WebIT course. In the schools at the test sites, each class met three times a week, in the computer lab. All classes were 40 minute periods. In the integrated approach, using WebIT, the exact timetabling arrangement was maintained. During the scheduled class periods, students worked through the online instructional material which included a variety of performance activities according to the type of unit as outlined above. The teacher spent time working with individual students, reinforcing concepts and ensuring that students were fully grasping the material. Periodically, the teacher could call for the attention of all students and teach some topic that may be giving problems to students using blackboard and chalk. There was also ample opportunity for group discussions.

The design of the WebIT Instructional System for this integrated approach took cognizance of the age and characteristics of the intended users. The course was highly structured and systematic. The web course was organized into a number of units/modules. These units were decomposed into topics then lessons, manageable 'chunks' of course material. Each lesson was intended to be completed in 40 minutes, mirroring the traditional classroom timetable. This was a lower level of granularity than in Case Study1, where course material was organized by topic rather than by lesson. The lessons consisted of combinations of types of material, including activities and exercises. Each lesson consisted of a lesson framework and lesson content. The framework identified clearly the lesson focus and objectives as well as an overview of the lesson content. Navigation icons in the course encouraged students to move through the course in a structured manner rather than facilitating random exploration of content. This was to encourage students to complete a lesson before moving on to the next. It also reduced the

likelihood of students getting lost in the virtual classroom, or students getting distracted and wasting time.

Careful consideration was given to synchronizing student learning to be able to fit into the school system. What was desirous in this integrated approach was that students of a given class should move forward topic by topic as a group as in the traditional classroom. However, within a topic, students could be at different lessons. While on a given topic, for faster paced students, the teacher would supplement the WebIT material or direct those students to additional resources on the web, as well as provide additional and more challenging exercises. Slow learners were not left behind. Individual attention, teacher encouragement, repetition of explanations (including alternative ways of explaining the concepts), and assistance with practical exercises helped the slower learner to master the topic and keep current with the class. In some cases, the teacher could encourage gifted children to move at a faster pace than the rest of the class and even complete the course of study (and take the CXC exam) in one year rather than the two year norm. Students also had access to the WebIT course from home computers (or from the public facilities such as libraries). The integrated approach provided an education environment that caters for the challenged learners but which also kept the advanced student excited about learning. The target groups of students for this course were younger than those discussed in Case 1. They generally lacked the maturity and self-discipline for independent study; hence the teacher played a critical role in guiding the process of learning.

4.3 Evaluation and Discussion

Prior to using the WebIT course, instructional materials were peer reviewed for academic integrity and organization of content. After the Integrated Instructional Model had been in use for one term/semester at the test sites, evaluation exercises were carried out via questionnaires and two focus groups with teachers – one in Trinidad and the other in Grenada. Two different questionnaires were used, one for teachers and the other for students. These evaluation tools were used to gauge the reaction of teachers and students to teaching and learning in an online environment and to get feedback on their perceptions of the effectiveness of the integrated approach. The IT course of study covers a period of two years. It culminates in students taking a final exam that is administered by the Caribbean Examination Council. Further research studies will be carried out by the authors to examine student performance at the CXC exams for the classes using the Integrated Instructional Model.

Teachers were asked to rate the teaching experience using the integrated approach. Questions on various aspects of the web course and the manner in which this was combined with face-to face instruction were organized into several categories as follows:

1. Instructional Design
   - Size and level of granularity of each lesson
   - Sequencing of instructional material
   - Ease of navigation of the web course
   - Blending of web-based instruction and face-to-face instruction

2. Quality of Instructional Material
   - Clarity of lesson objectives
   - Organization and appropriateness of content
   - Adequacy of practice and assessment exercises

3. Teacher-Student Interaction in the Integrated Approach
   - Support for individual student needs
   - Support for different learning styles
   - Provision of feedback and guidance

4. Support for Teaching Programming
   - Combined approach assisted teaching
   - Combined approach would encourage more students to write the General Proficiency

5. Overall Rating of the Teaching-learning Experience
   - Effectiveness of the integrated approach

Table 2 shows the aggregate rating by teachers for the categories above, using a five-point scale with 5 being Excellent and 1 being Poor. Overwhelmingly, teachers favored the approach.

Features	**Mean**
Instructional Design	4.0
Quality of Instructional Material	4.6
Teacher-Student Interaction	4.6
Support for Teaching Programming	4.5
Overall Rating of Teaching-Learning Experience	4.8

Table 2. Teachers' ratings of their experience using the Integrated Instructional Model

From the focus groups and one-on-one discussions with teachers some other interesting points emerged:

Integrating web-based education and classroom teaching in Caribbean secondary schools can serve to foster collaboration and cooperation among IT teachers of the region. Teachers would be responsible for guiding and teaching the students in their respective schools. However, they can share their experiences and expertise with fellow IT teachers within the Caribbean region. The web course would facilitate this communication. Many teachers expressed the view that this sharing of resources could be one of the most significant benefits of the combined approach to teaching.

In some countries of the Caribbean, there is a shortage of IT teachers or in some cases the level of teacher experience and formal teacher training is low. The web-

based course, developed by experts, provides a means of adding to the expertise that is brought into the student's 'classroom'.

From the survey amongst students, the web course and its use in complementing classroom teaching received very favorable ratings. 97% of the students rated the learning experience as being good or excellent (Figure 1). They gave high ratings to various aspects of the web-based course such as ease of use and presentation styles. One interesting statistic was that 98% of the students indicated that the web course and the greater interaction with the teacher stimulated their interest/desire to learn the subject.

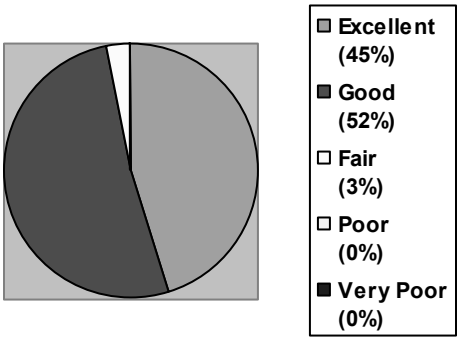

Figure 1. Students overall ratings of their learning experience

5. Conclusion

When these two case studies are examined, it is clear that an integrated approach to teaching provides many benefits. By combining web based courses and teacher interaction with students, both at university level and at secondary schools, students are getting the best of both worlds. For The University of the West Indies, where programs offered by distance have remained separate from face-to-face offerings, the experience gained from introducing a combined approach was a positive one for faculty and students. It produced more effective learning. The Caribbean secondary school system has no history of using distance education to deliver education programs. This paper provides a workable model for introducing web based technology education into the secondary school system in which the teacher still plays a central role in the life of those young students. Class sizes in the Caribbean are generally quite large, averaging 35 - 40 students. Content is generally pitched at the level of the class average and often does not cater for the gifted student or slow learner. The integrated instructional model allows for more individual student attention and caters for students of different learning abilities. It provides a combination of modes of teaching and learning well suited to students of this age group.

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