Hydrographic Learning 24/7

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ABSTRACT

The continuing explosion in communications technologies has impacted the way that formal education can be delivered to students seeking it. One element is the decreasing requirement for students to physically attend classes, exemplified perhaps by university courses delivered using television broadcasts, with the same material being available on videotape. When used their full capability, these technologies lead to more than delivery of the lecturer's words; they can include video clips and images that richen and broaden the learning experience. Most useful for courses designed to expound and transfer information, they do not meet the needs of participation and interaction traditionally met through the laboratory work required to properly teach some subjects. This role is being increasingly filled through the inclusion of interactive problem sets on CD in some textbooks, and through the development of open-access learning methods using the Internet. Happily, the many and varied advantages of the Internet as a teaching medium are being explored and expanded daily. Unhappily, it has one limitation that decreases its potential use in hydrographic education, in that the student needs to be connected to the Internet somehow. For most hydrographers on survey assignments, this is impossible or prohibitively expensive.

What is required to enable hydrographers to benefit from interactive learning is a suite of course material that has most of the benefits of an on-line course without the need for connectivity. This material would have to be self-contained, comprehensive, and capable of allowing exploration and giving feedback with little outside intervention. These are much more stringent requirements than providing a course on line with access to a vast array of links to backup resources.

Because of the clear need for hydrographers to continue their life-long learning, the Hydrographic Education in North America group (HENA) undertook development of the first self-contained hydrography learning module, "Horizontal and Vertical Datums, and Their Transformations". Doing so meant expanding the skill sets available to the group, since although we had a surfeit of subject-matter knowledge, the need to portray this dynamically and interactively required adding specialists in distance education to the team. We also acquired partners primarily interested in becoming or supporting

students but that are keenly motivated to support the project e.g., through input into the design.

INTRODUCTION

In 2001, Jimmy Chance from C&C Technologies challenged several of the authors to produce some "remote access" or "distance learning" or "open access learning" material for C&C employees, and the hydrographic community in general. Among the forces that brought us together to respond to this challenge were:

a) Growing awareness of potential use of Open Access Learning (OAL) to meet needs of life-long learning (often needed to maintain membership of professional institutions), and recognition of a strong and growing need for continuous training / re- training / updating due to rapid advances in knowledge, approaches, and technology. This is of particular importance for potential learners who cannot attend at one site for long time periods (for example, hydrographers at sea for extended periods). However, OAL was and still is in its infancy with no settled and time-tested methodology/approach. Some early attempts were cropping up and being used with varying degrees of success (for example MIT, 2003).

b) Recognition of specific hydrographic retraining needs to meet paradigm shifts presented by GPS and multibeam sonar technologies, for example.

c) Experience some of us had with computer-aided instruction, leading to glimpses of its potential value.

d) Perception that university-based learning, as well as life-long learning / re-training will be enhanced by including open-access elements.

e) A sense that we had a responsibility to the hydrographic community to attempt to meet the emerging need.

f) An atmosphere of collaboration between three universities providing hydrographic education in North America, i.e. HENA (Monahan et al., 2000)

Consequently, we put together an Open Access Learning At Sea Project (OALASP) (Wells et al., 2002). This paper describes accomplishments to date, evaluates what we have learned and suggests a course of action that can lead to success in the future.

GENERAL APPROACH

We began with the understanding that this project would be experimental, entailing a “learn as you go” approach, yet not aware of the full range of issues involved and what we would have to learn. Given the limited resources available, both human and financial, the project began modestly with the goal of developing a methodology for producing a learning “module”. A "course" consists of a collection of related modules. In a module, part of a subject is treated as a discrete block of knowledge (topic) to be taught/learned and is organized and assembled into a package that the learner can use. Modules are separate and independent from institution-specific information such as course number, syllabus, instructor contact, and so on. Advantages of this approach include: modules can be used in more than one institution or course, modules are self-contained so that they could be used and shuffled to suit various purposes and audiences, modules can be used in more than one course without much modification (Richer, 2003).

Based on what would be learned during this first phase, the next intended step was to produce a complete, usable demonstration module. This would be tested and evaluated by the partners with the help of focus groups, and the module would be refined based on feedback from this evaluation. Subsequently, we planned to expand this module into the equivalent of the classroom part of a one–term university course ("Geodesy for Hydrographers", for example). Practical field exercises would be a separate activity. Our (very) long-range goal was to expand the subject material into a full hydrographic education program, and eventually seek recognition of that program as meeting the classroom (but not practical experience) requirements for international Category A certification (FIG/IHO/ICA, 2002).

None of these results could exist in isolation and we planned to develop a strategy for delivering and managing these hydrographic learning modules and courses.

DESIGN GOALS

In establishing our design goals, we were well aware that a number of geomatics-related OAL venues were already available (for example Dana, 1999). Why create another? Our aspiration was to create learning materials of sufficient depth to be useful in supplementing university-level education, as well as open-access learning. For example, while information about GPS is available at a number of web sites, none (at least at that time) were designed with learning outcomes to support intelligent use of GPS in practice.

As hydrographic professionals (educators and employers of hydrographers), another reason for creating new OAL materials is the particular circumstances under which the learners could use the course material. We saw a growing number who spend long periods at sea or in remote locations during which they have considerable off-duty time but of course cannot leave the ship. They would have either “continuing education” or “academic credit” requirements (and these are not at all the same thing). Shipboard work schedules are asynchronous, so they would not likely have access to group-learning situations.

We were also aware of the revolutionary changes looming over all post-secondary (post-compulsory) education (Bransford et al., 2000; Dearing, 1997), that stress concepts such as motivation, active learning, learner-centric methods, and organizing information for practical use. We aspired to break new ground in bringing these concepts to open access learning.

Finally, and perhaps the most important design constraint, although some would have access to email, few would have access to the WWW. As an example of the pace of technological development, it is now possible (in a rudimentary fashion) to browse the web from cell phones, and many hydrographic projects such as harbor surveys can be within cell coverage. However, we have taken lack of access to the web as a design constraint, since easy and affordable web access at sea is still some distance in the future. This led us to conclude that ideal hydrographic learning modules would have to be on stand-alone CDs, perhaps supplemented with other documents like a textbook. A textual study guide could be built into the CD. We could not assume that the shipboard students would have all the necessary supporting textbooks and reference material like dictionaries at hand. Giving formative (informational) feedback to the students on their progress would be built in. However for summative feedback (marked assignments and tests) students would be able to use email to submit completed documents for marking.

Not having access to the web imposes a very severe design restriction, for a number of reasons. Computer-mediated discourse (discussion forums) has proven to be a powerful learning tool in OAL, but we would not be able to use it. Students without web access are not able to refer to other websites to obtain further information on each topic to supplement what our module provided, putting a severe onus on us to provide complete coverage of the topic.

Further design criteria included:

The material would not be linearly organized but would be based on the “browsing paradigm” wherein the learner could either follow the flow recommended in the study guide and implied by the interface, or would be free to jump about within the material, repeating some elements and skipping others.

Animations were considered as essential to demonstrate spatial relationships, as were interactive images that the learner can modify to observe the results of changing parameter values: both would be included.

Level of material was to be high enough that the learner would achieve Bloom’s level four (Bloom, 1956) i.e., the learner should be able not only to apply the concepts, but also to analyze the conditions under which each concept is appropriate to be applied. This would be achieved through numerical and expository active learning exercises. These exercises will require software with interactive mathematical capability to be incorporated in the learning materials.

Material would be available in English, French and Spanish.

Help and support would have to be provided on the CD. Ideally it would contain a learner’s guide, containing information about system requirements; the organization, structure, and navigation strategy adopted; hints and tips for learning; frequently-asked questions (FAQs) of a technical nature: a comprehensive glossary of terms, including text, graphics, and even interactive animations; a cross-linked index of symbols and equations; a list of hydrographic resources such as texts, reference materials, charts, www links to other resource banks; and information about software applications for training, learning and working in the field of hydrography.

We were to learn that this was a tall order!

STRATEGIES

Our strategy boiled down to “Ready, Fire, Aim”. All of us had achieved success using this vigorous and energetic strategy in the past, and there appeared to be little reason to believe that it would not work again.

One of the first strategic decisions involved deciding whether to try to “pick the low hanging fruit” or to work within a specialty niche. There are many arguments for the former; for instance first year courses will sell more copies and recover costs more quickly, leading to the generation of profit or a course that could be sold for a lower price. On the other hand, specialty higher-level courses will attract a smaller audience and costs per unit will be higher.

Economics are one consideration; level of difficulty of designing and creating material appropriate to the level of the course is another. The relationship between level of difficulty for the creators and complexity of the subject being taught is not a strict linear one. Unfortunately, there were no guideposts to help us on this.

Choosing the subject matter for the demo module was another thorny issue. The first module was on datums and datum transformations. Did we start at the right place? Even though it might be argued that datums are part of the foundation of hydrography were they the correct module to start with? They are not sexy, are more or less amenable to animation, and not likely to have video clips. Furthermore, since they are part of the entire field of geomatics, it might have been better to leave them to some other group and concentrate on a purely hydrographic topic like echo sounding? On the other hand, a successful module on datums could have wider appeal and be acquired by a larger learner group. The second topic, projections and geodetic calculations, also has a wide appeal.

We could perhaps have spent more time debating the audience the demo module was going to *demonstrate* to or defining what we meant by demo. Some of us thought that the demo’s purpose was to demonstrate the concepts to decision makers, others that it was a production-line teaching tool. These are widely divergent views, each of which if carried to its conclusion would have produced a different module. This also absorbed energy: for example, as stated in the design parameters, mathematical capability was seen as being desirable. However, there is a big difference between being able to demonstrate what one would do with this capability and actually installing real capability on the demo module. (For instance, the outcome of our debate about using Matlab as opposed to using some other math software did not matter for a demonstration but it would be significant in production mode.) Ultimately, to be successful, the module must be designed for the learners, not the decision makers.

PROGRESS ALONG THE WAY

Most of us began the project by acquiring an additional title. Rather than being hydrographers or professors or geomaticians, we discovered that, for this project, we were or would have to become, Subject Matter Experts (SMEs). That tells a lot. We were already experts in our field, and most of us had long track records of conventional teaching behind us, but for OAL, we would have to acquire new skills for a new role.

The new title implied that there would be other skills required for the project to succeed, and that we SMEs would have to either learn those skills or find people who possessed them already. We did both. The approach used in the datums and datum transformations module was to recruit a technical team consisting of web designers and animators led by a course designer from the UNB College of Extended Learning. For

SMEs used to preparing their entire course material, student handouts and lecture slides themselves, this required a mental adjustment. SMEs had to convert their traditional learning materials into a "story-board" format, and their ideas into multimedia learning objects, in order to communicate with the technical team members. Feedback from the results produced by the technical team led the SMEs to create refined storyboards with new learning ideas and richer multimedia objects, and a productive cycle of improvement took hold.

In a somewhat different manner, the module on projections was created by an SME, who initially created the module as two MS Word documents with embedded links. This allowed navigation through the text as would be possible with the final product on CD. However, at that stage it did not have the “look and feel” of the other module: that would have to be added by the technical team.

Another SME developed a Matlab program for the display of polar motion in 3D using real data from the International Earth Rotation Service. An unexpected side benefit was the ability to show polar motion over an individual period (of length 14 months) and its variation in amplitude of motion. While this was not the original intent, its usefulness became apparent during development.

WHAT WE LEARNED ALONG THE WAY

We learned at a number of levels. Probably our most important learning came from the “Focus Groups” established within the two sponsoring organizations (C&C Technologies and Canadian Hydrographic Service) to test the module as it progressed. They were able to provide feedback on what they saw from the viewpoint of the learner. (It is tempting to say “viewpoint of the client”, but the client might be considered the organization that the learners are employed by, and we needed the input of actual learners). We were able to modify and improve our approach to design as a result of this feedback.

A great deal of individual learning took place on the part of the SMEs. Although we were all well versed in presenting graphics and equations to live classes, we found that thinking about a student attempting to learn from the same material without the benefit of an accompanying lecture forced us to reexamine the way we would portray the material. In addition, classroom material is seldom designed for individual dynamic interaction while OAL can be, and perhaps must be to allow maximum benefit. To learn how to take advantage of this double opportunity, SMEs began experimenting with animations and math-driven models of various complexities. Some involved their students: for example, one SME supervised a student project that developed an interactive animation of precession and nutation using Matlab.

Our learning was greatly increased through it being positioned in an iterative, inter-related cycle. Input from the learner focus groups helped to ensure that the product would satisfy their needs and be compatible with their equipment and working environment. This in turn helped educate the SMEs as to what was possible technically, developing their awareness to the point that they really could leverage the power of the technology. Both these activities led to the technical specialists (animators and such) developing a greater understanding of the content itself, which allowed them to develop an approach that best suited for explaining and amplifying learning of the subject matter.

This lead to some wider scale learning, and those findings are probably applicable to most future endeavors in OAL. In no particular order, they are:

1. Producing even one module is a big undertaking. Producing and entire university level course will be big x big.

2. There is a lot of work in the front end / user interface / non-subject matter items. Successful completion of these elements will usually require the application of specialist skills.

3. Illustrations used in static texts don't always convert easily to animation. Usually an entirely new graphic has to be envisioned and created for animation mode. (Even if there are good graphics available, there may be copyright issues.)

4. It is highly beneficial to test the developed material in a University setting where students can directly interact with the authors of the material and modify it before sending it to the focus groups for remote testing.

5. Regular meetings of the SMEs and the technical team are essential to maintain progress.

6. Don't be blinded by the technology; don't stray too far from the basics, from the familiar classroom experience. This will be less demanding (time/effort/learning curve) on the SMEs and might help learners relate to what they already know. “Bells and whistles” should only be used when and where they bring real value to the learning experience or simplify/enhance the task of teaching; if certain elements are best presented as text and static diagrams, then by all means present them as such.

7. Our scarcest commodity has been SME time to devote to this project. By definition each SME is already very busy, and this OAL activity had to compete with many other demands seemingly having higher short-term priority. However, our expectation is, that once a few demonstration modules are complete, the evident value of these new materials will provide increased incentives. Also, once the SME "learning curve" is over, the process will be well defined, and progress on subsequent modules make more efficient use of scarce SME time (both for those of us involved in this project, and those who follow us).

8. It is prudent to develop something that's fairly familiar to both SMEs and students, at least at first. Given the learning curve involved, start with material that's already available i.e. lesson plans, presentations, diagrams, question banks and such. Adapt material already proven in the face-to-face mode to the computer-based mode, so that SMEs would be able to concentrate on content and the technical team on production details.

9. The real value of the learning material comes from its content and design, not from its format and technology. Both are important, but the latter is ancillary to the former.

WHERE DO WE GO FROM HERE?

The following is a "wish list" of future projects and objectives, laid out in a loose chronological order.

First stage - *Datums & datum transformations*: deliver demonstration module to clients

Second stage - *Geodesy for Hydrographers* (Currently projection section nearly complete – geodetic computations 50% done) to be used at UNH (with similar courses at USM and UNB)

Third stage - *Tidal theory and practice* (Content experts from NOAA, CHS, ENCI)

Fourth stage - *Multibeam sonar concepts* (Preparation for 6-day Multibeam Sonar course)

Fifth stage - Open Access FIG/IHO/ICA Cat A program

SUMMARY

The need for open access learning at sea has been identified. Two founding clients (C&C Technologies, CHS) sponsored initial development and formed focus groups that evaluated progress along the way. Some of the achievements so far are:

1. An SME team has been assembled with members from:

    USM Hydrographic Sciences Program

    UNB Dept of Geodesy and Geomatics Engineering

    UNH Joint Hydrographic Center

    Centre Interdisciplinaire de Développement en Cartographie des Océans (CIDCO), Rimouski Québec)

2. A technical team, led by the UNB College of Extended Learning, and including Jamie Davis from USM, has been assembled and are adapting the SME's ideas and learning materials.

3. Design standards & macro-design are complete

4. Three modules are at an advanced stage of completion:

    "Horizontal and Vertical Datums and their Transformations"

    "Map Projections"

    "Geodetic Computations".

5. Learning and insights gained by the team are having beneficial spin-offs. For example, a blueprint for the development of future tech-enhanced courses in science and engineering has been prepared and is in use (Richer, 2003).

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