Lessons Learned Providing Distributed Learning During Military Operations at Sea

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ABSTRACT

The US Naval operating forces are committed to extensive worldwide deployments in support of national military objectives. During these deployments, selected Naval personnel receive graduate level instruction through enrollment in a series of Information Operations courses from the Naval Postgraduate School. These courses have been successful and provide uniquely relevant Internet-based graduate level educational opportunities. The operational application of these courses, coupled with real-world observations from Operation Enduring Freedom and Operation Iraqi Freedom combined to form a coherent framework and positive learning environment for studying Information Operations, Information Warfare and Space-based Command and Control, Communications, Computer, Intelligence, Surveillance and Reconnaissance (C4ISR) applications. Despite the demanding nature of deployed Naval operations, as well as various inherent distributed learning challenges, student-teacher persistence enabled exceptional achievement because the Postgraduate School tailored the course to suit high tempo of deployed naval operations. "Lessons learned" from these initial web based initiatives, include bandwidth/firewall issues, operational security and a host of "customer" centric issues. All of these critical program factors have been incorporated into subsequent distributed learning course offerings. NPS's flexibility accommodated the increased fleet workload by adapting delivery method, assignment sequence, online discussions, and offering alternative course completion dates. The Naval Postgraduate School, teaming with deployed sailors, has proven a concept for providing educational conduits that elevated awareness through relevant, flexible course material. The Navy is now committed to creating and sustaining a graduate level distributed learning program that provides challenging and operationally relevant educational programs for deployed forces.

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INTRODUCTION

The Navy in the twenty first century will increasingly face national security environments that are turbulent if not chaotic, with strategic and tactical objectives that are fluid and imprecise, employing sophisticated technologies that are as complicated as they are powerful. While we would hope to enjoy substantial technological advantages over all our potential adversaries, the decisive factor in determining the success of our engagements will always be the intelligence, insight and creativity of our commanders who will employ our defense assets in a wide variety of scenarios, not all of which can be fully anticipated. The intellectual capital of our armed forces, throughout the chain of command, is and will be the critical competitive advantage that will avoid and contain conflict where possible and ensure victory when necessary. The Naval Postgraduate School's mission has always been to prepare the future leaders of the Navy to be able to apply critical thinking skills in their quest for heightened mission readiness and a long lasting competitive advantage.

In 1997 some at the Naval Postgraduate School (NPS) realized that the trend in "e-learning' was clearly moving in the direction of the institutions of higher learning and it was already being embraced by DoD, in many areas of training. A great deal of skepticism regarding web based learning initially pervaded colleges and universities throughout the world and the range of skepticism was wide, everything from a lack of historical data, to quality, to cost, to inadequate Return on Investment. At NPS, like many other universities and colleges, neither command support nor funding resources were forthcoming with respect to initiating a Distributed Learning (DL) Program for anything that involved an overt move towards incorporating web learning technologies in any significant way.

In 1998 the Office of Secretary of Defense for Personnel and Readiness began their Advanced Distributed Learning (ADL) Initiative and the Navy's Chief of Naval Education and Training (CNET) published a Distributed Learning Strategy for the Navy. That was the catalyst for the NPS Distributed Learning Program.

Plans were put in place to begin developing unique, relevant, Navy web based "Graduate level" course content that could be made available to active duty Naval Officers who either might not be able to attend NPS for a full masters program or might not be able to find the time in their busy careers to attend NPS at all. In 1999, in partnership with CNET's (Now Naval Education and Training Command) Education and Training Strategies Division, the cadre that would become NPS' Office of Continuous Learning (OCL) began receiving Education 'Re-engineering' Funds and initiated the development of a formal Distributed Learning Program, using the Information Systems and Operations (ISO) curricula at NPS as the first set of piloted NPS Online Graduate Education courses. By 2001, NPS had formerly begun a variety of DL programs to provide greater access to graduate education by Naval officers who were either shore based or in a deployed "at sea" status.

In September of 2001 NPS began 'beta' deliveries of one of the courses in the ISO curricula. This newly developed web based course, Space Systems Technology and Applications (SS3011), was made available to students deployed aboard Naval combatants, as well as other locations worldwide. Today NPS has over thirty fully online Graduate courses and complements another 250 resident and Video-TeleEducation (VTE) courses with web based learning supplements and modules. The web based, online courses that have been delivered, have

successfully attained educational objectives, both in extended constituent reach and academic rigor, and epitomize the concept of tailored relevant education for deployed operators. The military and operational relevance of these course offerings is considerable and provides a framework for the student to consider limitations and applications in critical areas such as Space based C4ISR assets which support USN maritime and power projection operations.

Feedback from the students currently enrolled in the Space Systems Technology and Applications educational effectiveness follows:

- "I have a much better understanding of why our satellites are positioned based on mission. Additionally, I have a better understanding of what interferes with satellite performance."

- "The course has increased my understanding of space applications most definitely - on both a general and tactical level."

The value of challenging, cutting edge courses, specifically tailored around high optempo for deployed forces cannot be overstated. The students who completed the course were representatives of the ship's company, embarked staffs and airwing personnel. During perturbations in class interaction due to operational schedules, and joint forces operations such as Operation Enduring Freedom (Afghanistan) and Operation Iraqi Freedom, the Naval Postgraduate School demonstrated accommodation of the increased workload upon fleet operators by flexible course adaptation. These real-time course modifications included an adjusted delivery method (transitioned high bandwidth media delivery to more dependable low bandwidth), resequencing of assignments and discussions, and offered alternative course completion dates.

The Navy's Chief of Naval Operation (CNO) has strongly emphasized education as a means to both retain our highly skilled personnel as well as demonstrate commitment towards elevating their knowledge and skill level. *"Our commitment to our Sailors involves a solemn promise; offering them the best opportunities for training, education and personal growth". (Clark, 2003)* Naval educational providers have previously established sponsorship and funding of traditional educational programs. An equivalent educational imperative is necessary to fully establish and fund a structure that offers a challenging, Navy relevant program to deployed Naval personnel. The pacing of information and fusion technology, employed in both offensive and defensive roles, demands an educational conduit to elevate awareness of its effective use and adaptation.

The Information Systems and Operations (ISO) Certificate, offered via distributed learning (fully web based) from the Naval Postgraduate School meets this demand and is an excellent example of a baseline educational program which not only offers substantial tactical relevance relating to improved technical capabilities, but also significant progress towards a postgraduate degree for those deployed learners, or other who cannot attend the Naval Postgraduate School. The four course sequence in the Information Systems Operations Certificate Program is SS3011 (Space Systems Technology and Applications); IO3101 (Introduction to Information Warfare); IS3502 (Introduction to Networks); and IS3302 (Database and Decision Support). Focused content domains, awareness of pedagogical differences in delivery and the strong operational linkages of these distributed learning courses, paired with emergent Naval Forces innovation such as Navy Fires, Network Centric Warfare and Time Critical Targeting provide an instantaneous means to elevate user sophistication of weapon system employment opportunities from both a technical and tactical standpoint.

In July of 2001, NPS was asked by RADM Thomas Zelibor, Commander of the USS Carl Vinson Battle Group, to offer the Space and Technology Applications (SS3011) course to members of his Wardroom aboard USS Carl Vinson, which was deploying in September of 2001. The first week of September, 22 Officers, including RADM Zelibor and his staff communications officer, began taking a fully web based Graduate Level course about a Navy combatant ship.

With the events of "9/11", RADM Zelibor and 10 other officers were forced to withdraw from the class, due to workload issues and operational commitments.
Eleven officers, however, including the USS Carl Vinson N6, continued with the course of study and successfully completed SS3011 while deployed during Operation Enduring Freedom.

Successful Strategies for Deployed Students

Including any group of Naval personnel as student class members, much less a group deployed aboard ship and conducting daily operations, for a distributed learning course poses unique and substantial challenges to providing the class environment normally sought to ensure success. The major reasons for this are due to: the demanding nature of their jobs and billet responsibilities, the heterogeneous connectivity configurations, the temporal differences between locations, the limited access and priority for non-mission essential communications and, most of all, the

challenge of keeping the learner motivated and engaged. These challenges do not prohibit a successful or rewarding education, but do require explicit coping strategies for each of the potential hurdles identified.

Several practices which have proven valuable in creating and presenting an educationally effective Space Systems Technology and Applications distributed learning course are: explicit consideration of the deployed learning environment, creation of a defined and valued course presence, definitively monitoring student-course interaction, and coping with restrictive bandwidth. The Naval Postgraduate School's Faculty Development Programs focus as much on Faculty/Learner Strategies in the Navy Learning environment, as they do on Pedagogy and 'Best Practices'.

Effective Course Design

As a practice, to foster a shared sense of purpose, provide mutual support, and create a sense of social cohesion, the designers and instructors of distributed learning curricula seek to develop a shared sense of educational purpose within the course offerings. A sense of aloneness and solitary achievement may quickly onset for individuals participating in a distributed learning course, particularly for students participating in their first course, or for students who also experience focused stressors such as competition with personal and family time as well as unpredictable disruptions to routine that is commonly seen during operational periods.

There are recognized measures that can successfully work to create the desired atmosphere and student relationship. Specific strategies that can be implemented and emphasized are the construction of a clear, complete and interesting course presence, fostering of student commitment towards creating worthwhile dialogue and class work products. In addition, enthusiastically reaching out to students regularly, with particular emphasis on students' whose attention and participation is markedly lacking can have an extremely positive effect.

The educational philosophy that realizes the effectiveness sought in graduate level courses emphasizes synthesis of topical material, development and analysis of quantitative elements, frequent writing, and collaboration among peer students. It is this interaction that is the real 'crux' of meeting graduate level goals and objectives.

While some aspects of the course may be completed alone, the majority of assignments require proposal and defense of ideas as well as quantitative assessment of physical behaviors (e.g., orbital mechanics). Progress through the course requires engagement with the course material in venues providing the learners with both social and educational benefits. Strong instructor-learner and learner-learner associations provide ample opportunity to develop new relationships and collaborate on course assignments, but perhaps more importantly, a sense of shared commitment is developed among coherent class teams. (Ko 2001)

Student relationships cement the participation in the course, solidify a sense of community and thus, greatly reduce the probability of withdrawing. Additionally, if a "community of learners" can be formed both online and in a cohort situation as may be found aboard a ship, there are tremendous benefits in terms of shared understanding, participation and cohesion. Six students aboard USS Vinson repeatedly mentioned the "chalk talks" as a significantly beneficial aspect of the course. An institutional student-scheduling goal, if at all possible, would be to group students aboard larger combatants within the same class or educational cohort to allow peer discussion and support.

Since there are homework assignments each week, the degree of visibility towards the specific progress and problems of each student are visible and explicit. Progress in a DL class is apparent, as there are no opportunities for generalizations or "head nods". This is both an advantage and a challenge. An advantage because learning disconnects are immediately apparent and may be dealt with quickly. They are disadvantages because the amount of effort to gain assent or a comfort level on the most direct topics may be considerably greater than that experienced during a resident class session.

A notable observation of great potential benefit is that student cohorts (each cohort of five to nine students) progressing through educational course sequences are much more successful in completion and educational interaction than are individual students. There have been two classes of SS3011 comprised largely of a cadre of students migrating through a twelve course resident MS program. Their participation and level of collaboration was very impressive and immediately elevated the thoroughness of participation as well as the time allocation for collaborative products. This environment and presentational structure demand peer progression through the course material. The collaboration is better facilitated as all students are at equivalent progress and a sense of supporting the classmates is created. It was an optimal learning environment. Also, none of the participants from these groups failed to complete the SS3011 class. Replicating the cohesiveness of these cohorts should be particularly pursued and implemented, and can be most important for distributed learning courses.

Creation of Course "Presence"

The web site (Course Management System, in this case; NPS uses Blackboard) which hosts and presents the Space Systems Technology and Applications must convey a worthwhile location to visit, peruse and collaborate. This site is the "classroom" and improves the student interaction with the course material with the inclusion of intriguing questions, highlighting of current and relevant events, and constantly refreshing the informational content. In addition, occasional members of the class have significant experience in related space fields and serve as an additional conduit to renew presentational materials. The web site facilitates these students to become resources to their peers in supporting further discussion and research.

Professional interaction with space products, space systems, and DOD space systems organizations is strongly solicited to enhance course presence. "Guest speakers" have been used to shadow the course presentation and progress, participating frequently to provide observations or summaries that are uniquely relevant. For example, during the course modules which covered military satellite communications systems, a guest instructor was participating in the redesign of the DOD satellite communications architecture and supplied compelling and timely observations regarding the redesign criteria. The virtual and enduring presence of these "guest" instructors builds a strong linkage. The students then poll these contributors subsequently for additional perspectives and information.

The NPS library also provides an excellent range of materials and electronic resources for the students. The course web site serves as a portal to the extensive electronic resources available through the Dudley Knox Library. Many students, particularly those taking their first distance learning course, find the availability of electronic research to be extremely valuable, frequently using e-mail full-text retrieval of vast resources for their research areas. The library and peer reviewed research is a vital component of a postgraduate course.

Flexibility and Establishment of Expectations

Distance learning interaction can be occasionally frustrating. For new students, or those unalerted to the occasional interruptions, minor troubles may lead to disengagement from the course. For this reason, a clear delineation of expectations for course interaction, pacing, and participation is essential. Equally important is the need to establish the understanding by each student that the distance learning environment does allow the accommodation and remediation of learning opportunities that are missed due to operational or mission requirements. While the progression of a student independently throughout the entire course requirements is decidedly not desirable, there are frequent occasions where students may anticipate travel or operational absences and deliver their part of a collaborative effort in advance of departure. Alternatively, should several students fall behind due to job or family responsibilities, they are easily regrouped and provided with adjusted assignment dates.

Communication interrupts are extremely frustrating if not expected. It is important to establish an expectation or understanding that there will be frustrating times during connection interrupts, and that this is realized and will not adversely impact the student's grade, participation or learning. In almost all cases, there is the opportunity to reengage through e-mail dialogue, e-mail sharing, mailing a CD, or resuming course participation when the connectivity has improved.

Beneficial Course Management Features

An effective course management system (CMS) greatly standardizes the expectations and interactions when students engage with course presentations, instructional media and assigned activities. In addition, this provides a level of consistency and comfort as the learner moves from one class to another. The pillars of instructional support for a successful site are:
(1) clear and constant expectations, (2) presentation of objectives, (3) description of required readings, (4) summary of important points for the week's assignment, and (5) a clear description of the current writing assignment.

A clear and consistent presentational standard offered by the CMS serves as the map for course interaction. Building this map with a minimum of navigational tokens (bars, site maps, etc.) and an emphasis on instructional delivery serves as a useful and desired course design goal. Presentational features of many common CMS's "wrap" the educational content in a quickly understood and appealing interface.

As the students proceed through the first two weeks of the course, they are monitored closely for course access through the course statistics feature of the CMS. This feature tracks and tallies the number of times each student visits a section of the course web site (supplemental reading, e-mail, and group discussion boards). This capability is imperative to initially guiding the student to a successful behavior pattern for future course interactions. The opportunity becomes available for discussing clarity of expectations and level of interaction with specific students. Additionally, as the course progresses, the course statistics feature allows observation of progress with course material and collaborative assignments and provides a view, by individual, of progress and course engagement.

Behavior patterns for course access emerge allowing the instructor to offer assistance or flexibility in assignment completion for enthusiastic, participating students who have experienced temporary difficulty.

Restricted Bandwidth and Limited Resources

While conducting military operations at sea, students enrolled in the Space Systems Technology and Applications class commonly face a pair of hurdles in accessing the online class environment, restricted computer access and bandwidth limitations.

As one student aboard the USS Carl Vinson noted;
"We have 5000 people trying to access the same bandwidth pipe. Knowing when "rush hour" is helps me avoid delays and frustration."

For most embarked students, available computer stations represent a shared resource and careful planning must be done to assure regular access. An effective means to assure access to essential resources is to solicit endorsement by the Commanding Officer. Securing command support for the educational opportunity and time commitment is essential during the enrollment and throughout course participation. The leadership and mentors for the Naval personnel are able to make a significant difference, both in recognizing notable educational accomplishments that relate directly to Naval missions as well as leveraging the opportunities to enhance the learning experience

A second challenge that requires careful management is in accommodating limited data rate access to web based course materials. Data throughput that is considered low bandwidth stateside (56K) is much more than is routinely available to the participating students, deployed at sea. Shore based students typically have dial up access (56K) at an absolute minimum and often have higher throughput at home (DSL or cable) or at work (T1 or T3). Again, intervention and support by command leadership aboard the USS Carl Vinson, on behalf of students engaged in DL courses, provided somewhat better access to adequate technological resources. There are efforts that commands can take to assist with access to adequate resources. In most cases, intervention by the embarked staff to set aside terminals for a specific time or to allocate a higher priority for participating students made a significant difference. In one case, there was no effect. Early involvement and advocacy of the CO and the N6/Communications Officer are extremely effective in providing support. For ships facing imminent deployment, the adequacy of access may be determined during predeployment at sea periods.

Again from the USS Carl Vinson Battle Group:

"Communications are much better! We have been receiving an incredible amount of support from the Admiral's Staff. "

Deployed combatants typically access the Internet through one or two Inmarsat channels, with each channel providing 32K of bandwidth. The Inmarsat channels are not dedicated to a single user's station and are further distributed to multiple users, thus reducing the realizable data rate apparent to a student participating in a web based course. In several cases, the communication interruptions and poor reliability did not adequately support the required educational interaction for extremely motivated and committed students. These students were not able to maintain a web session of sufficient duration to view even the minimum of educational content, or retain a session for sufficient time to complete an assessment. In these few cases, for limited intervals, the course participation was sustained through voluminous use of e-mails. E-mail connectivity remained reliable as the e-mail downloads would proceed at available times during the intermittent exchange of most other traffic. The students did use these periods of e-mail exchange to sustain an otherwise very successful course experience. It should be noted that the instructional effort to maintain the e-mail focused course interaction is considerable, elevating the time to administer the course nearly three-fold, during that period.

As much as possible, it is very important to develop an institutional and course delivery strategy that limits the recurrent demand on bandwidth. For example, educational components, particularly the larger components which are static may be placed on a DVD/CD and mailed to the students. Their access to this media is then immediate and the bandwidth channel may be saved for course discussion and critique. Additionally, the value of a clearly written, comprehensive textbook for students with little access to other academic resources cannot be overemphasized. In many cases, the students laud the textbook for clarity, clear presentation, and reference to equations. The Space Systems Technology and Applications course depends approximately half on textbook material and half on supplementary readings (fifteen core documents and related current discussions). It is worthwhile to note, that some of the flashy and media rich presentational content normally emphasized as a compelling element of web delivery may not be readily available due to constricted bandwidth for deployed personnel.

Additional course components such as simulations and visualizations, essential to understanding the three dimensional relationships between orbital bodies, are conveyed through a small orbital analysis software program that allows the students to establish orbits graphically and observe changing relationships and orbital parameters are varied. This orbital analysis software, distributed through the course CD, is an excellent substitution for software such as Jtrack-3D (NASA Marshall 2003), or Trimble's GPS tutorial (Trimble 2003) that are otherwise available through Internet delivery.

The priority for these courses materials will remain approximately the same, therefore course provisioning, and delivery for mobile, and at sea units (disadvantaged terminals) should be considered, accordingly. The competition for quantity and priority of bandwidth available for DL course interaction will not abate and perhaps will increase during near term deployments. Operational demands upon bandwidth are increasing. During Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) in particular, imaging and reachback communication requirements appropriately dominated communication requirements.

Careful Instruction in Quantitative Analysis

Adept use of mathematics and quantitative skills is an absolute necessity for high quality postgraduate courses. The Space Systems Technology and Applications class, while not requiring calculus or differential equations, does depend a great deal upon advanced algebraic concepts and trigonometric relationships. Prior to enrollment and at the course onset, the students are advised of the depth of math required to be successful. The mathematical constructs used to convey orbital dynamics and communications path loss relationships are described very well within the textbook, including an excellent foundational treatment of vectors and mathematical relationships. The course textbook, in large part, was selected due to the clear and careful development of related mathematical equations. Also, additional instructional and remedial opportunities have been created through various arrangements; via phone conversations, through carefully created Power Point presentations that include motion and audio, and via carefully drawn diagrams that were then e-mailed to the student.

Fortunately, there are many capable peer tutors aboard most combatants willing to assist with mathematical instructions. The enrolled students showed great initiative and persistence in locating these math tutors and identifying the success of the onboard instruction to peer student shipmates.

Summary

Course completion rates for the six most recently delivered sections of the Space Systems Technology and Applications course are provided in Figure 1. The relatively high course completion rates for sections comprised predominantly of operational (deployed or participating in work ups) students underscores the achievement of successful course delivery.

SS3011		**Start**	**Finish**
AY02	**Q1**	23	11
AY02	**Q2**	23	15
AY02	**Q3**	15	9
AY02	**Q4**	23	17
AY03	**Q1**	21	11
AY03	**Q2**	23	17

Table 1. SS3011 Class Completion Rates

The characteristics that lead to a thriving educational interaction are reasonable and attainable. Success in providing a graduate level course to deployed students in a challenging environment is earned daily, on almost student-by-student basis.

Since both the international security environments and the technological sophistication of defense systems are changing at unprecedented speeds, our officer corps can no longer remain current by a single immersion in graduate education, however well conceived. It is imperative that all our armed forces be provided with continuous learning opportunities throughout their entire military careers.

These methods may include delivery of graduate classes to fleet concentration areas by visiting NPS faculty or education via video teleconferencing systems. However, most certainly, emerging technologies will allow an increasing emphasis in providing on-line learning opportunities through web based or web supported education. NPS is committed to supporting the Naval Fleet activities through expanded access to NPS' web based course content and other outreach programs that will go well beyond the population of residential graduate students, to include officers, enlisted, defense civilians, reservists, allies, and NPS alumni. The benefits of such programs include:

- Reduction of time in residence for full time graduate students who will complete prerequisites and refresher courses before they arrive on campus,
- Delivery of graduate education to those who are unable to come to NPS,

- Rapid dissemination of critical strategic and operational research findings to keep decision-makers current.
- Furthering the Navy's vision of a Learning Continuum for all Navy military and civilian personnel
- Ensuring the Navy has necessary critical thinkers and decision–makers required to maintain Seapower 21 dominance.

Although the NPS resident experience will continue to be of greatest value to the majority of learners, the faculty – student contact, supplemented and enabled through online course discussions and interaction, with the Fleet 'learners' will become increasingly central to organizational and educational quality of all the NPS Graduate Programs. The focus will remain on meeting Navy education requirements and ensuring access to that content which best serves unique Navy students where they are rather than centralizing critical education content in a single location NPS will enhance its efforts to help learners to develop the skills necessary to be successful in an ever changing, chaotic Navy operational environment; an environment which necessitates developing creative approaches to problem-solving and decision-making, as well as other critical thinking skills. In this sense, NPS will orient its education strategy to ensuring that students know how to learn, apply what they learn, and then have the capacity to adapt, as required, to Navy mission critical situations. The Naval Postgraduate School will continue to play a pivotal roll in educating tomorrow's leaders throughout the "learning continuum" envisioned by the US Navy.

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