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Arizona Telemedicine Program Interprofessional Learning Center: Facility design and curriculum development

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Abstract
The Institute for Advanced Telemedicine and Telehealth (i.e., T-Health Institute), a division of the state-wide Arizona Telemedicine Program (ATP), specializes in the creation of innovative health care education programs. This paper describes a first-of-a-kind video amphitheater specifically designed to promote communication within heterogeneous student groups training in the various health care professions. The amphitheater has an audio-video system that facilitates the assembly of ad hoc ''in-the-room'' electronic interdisciplinary student groups. Off-site faculty members and students can be inserted into groups by video conferencing. When fully implemented, every student will have a personal video camera trained on them, a head phone/microphone, and a personal voice channel. A command and control system will manage the video inputs of the individual participant's head-and-shoulder video images. An audio mixer will manage the separate voice channels of the individual participants and mix them into individual group-specific voice channels for use by the groups' participants. The audio-video system facilitates the easy reconfiguration of the interprofessional electronic groups, viewed on the video wall, without the individual participants in the electronic groups leaving their seats. The amphitheater will serve as a classroom as well as a unique education research laboratory.

Keywords: *Interprofessional, interdisciplinary, telemedicine, telehealth, team training, distance learning, video conferencing, human performance studies*

Introduction

Traditionally, the education of doctors, nurses, pharmacists, and public health professionals has been carried out in separate tracks or ''silos''. These educational tracks are discipline-specific, narrowly focused, isolating for the students and, typically, self-centered. The classroom facilities are often in separate buildings and run by different administrators. The practitioner-faculty members within a track are recruited from within their respective

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disciplines. Cross training between discipline tracks is uncommon, is often undervalued, and can be perceived as an exception to the rule when it does occur. Although there are concerns that the current discipline-centric education model inadequately addresses some of the important aims of the health care mission, the discipline-centric education model is deeply entrenched in Western society (Greiner & Knebel, 2003; Weinstein & López, unpublished observations).

The current health care education enterprise would be difficult to reorganize on a large scale. Academic health care professionals are protective of the boundaries that define their individual disciplines. They respect, and rely on, the professional boundaries of their individual disciplines, which they instinctively guard, even as students. Of course, this sense of ownership is not unique to the health care professions and is found in other professions as well. However, with respect to health care workers, the blurring of professional boundaries in order to create more efficient and effective health care teams is challenging, even where the rewards could be demonstrable improvements in the quality of health care services of patients (Baggs et al., 1999; Counsell et al., 1999; D'Amour et al., 2005; Halland & Weaver, 2001; Ivey et al., 1987; Leathard, 2003; McNair et al., 2001; Satin, 1994; Schofield & Amodeo, 1999; Walsh et al., 1999; Zwarenstein et al., 2004). Across the health care professions, there are educators who are interested in exploring new strategies to expand the pool of interprofessional health care teams. However, the literature on interprofessional training contains many observations on the challenges encountered in educating interprofessional teams, as well as insights into the factors that effect group dynamics within interprofessional teams (Liedtka & Whitten, 1998; Malone & Crowston, 1994; Wells et al., 1998).

The strong endorsement in the United States by the Institute of Medicine (IOM) of the National Academies of Science of an interdisciplinary team approach to health care delivery and education has recently increased the visibility of interprofessional teams. This is encouraging educators to increase their efforts to develop interdisciplinary curricula and to incorporate interprofessional team training into their school's curriculum (Greiner & Knebel, 2003).

The IOM has had a major interest in the topic of quality of health care for years (Blendon et al., 2002; Kohn et al., 2000; Kohn et al., 2001; Wunderlich & Kohler, 2001). Its 2001 report, ''Crossing the Quality Chasm: A New Health System for the 21st Century'', identified the magnitude of the health care quality issue in terms of deaths each year in the United States tied to quality of care issues (Kohn et al., 2001). The report described the IOM's intent to take measures to improve patient care and safety. In 2003, the IOM published a follow-up report, ''Health Professions Education: A Bridge to Quality''. This report noted that ''although the academic environment of the various health professions generally are not interdisciplinary, practice environments are increasingly so, posing a serious disconnect''. The report proposed that a collaborative approach to education reform be undertaken in order to promote collaboration among clinicians in practice settings. A recommendation in the report was for ''... the developing and funding of regional demonstration learning centers, representing partnerships between practice and education. These centers should leverage existing innovative organizations and state-of-the art training settings focused on teaching and assessing a set of core competencies'' (Greiner & Knebel, 2003).

The Arizona Telemedicine Program has a special interest in the training of interprofessional teams because interprofessional education can also contribute to the success of telemedicine and telehealth programs (Barker et al., 2005; Blanchet, 2005). Telemedicine programs may employ the services of numerous health care workers from many independent

health care organizations that can be physically located throughout a large geographic area (Weinstein et al., 2004; Weinstein et al., 2007).

The practice of telemedicine is inherently challenging (Blanchet, 2005). An unanticipated benefit of operating a university-based comprehensive telemedicine program has been the lessons learned about health care education through the Arizona Telemedicine Program's involvement in many different types of administrative, education and patient care video conferences. It remains to be seen if any of these insights are applicable to the development of new interdisciplinary health care student team curricula.

This paper describes our progress in creating a regional demonstration learning center for interprofessional training that incorporates telemedicine and telehealth as core competencies.

Evolution of the concept for the Arizona Telemedicine Program Interprofessional Learning Center

Arizona is the sixth largest state in the United States. Its only allopathic medical school was founded in 1967 and is headquartered at the University of Arizona campus in Tucson, Arizona. The largest city is the state's capital, Phoenix, located 100 miles northwest of Tucson.

In 2004, the Arizona Board of Regents, the governing body for Arizona's three state universities, made a decision to establish a branch campus of the University of Arizona College of Medicine in downtown Phoenix. Three unoccupied historic high school buildings, originally built in 1911 and 1912 and totaling 85,000 square feet, would be renovated to house its first class of 24 medical students by the summer of 2007.

As part of its initial decision to move ahead with the development of a University of Arizona College of Medicine Phoenix Campus, the Arizona Board of Regents named the Arizona Telemedicine Program as one of five enabling resources in its ''Memo of Understanding'' that created the University of Arizona College of Medicine Phoenix Campus. The four other entities were The University of Arizona, Arizona State University, Northern Arizona University, and the Translational Genomics Institute (T-Gen), a free standing not-for profit research institute located on the same property as the University of Arizona College of Medicine Phoenix Campus. The national award-winning Arizona Telemedicine Program is known for its innovations in telehealth (Blanchet, 2005; Weinstein et al., 2004; Weinstein et al., 2007).

The Institute for Advanced Telemedicine and Telehealth (T-Health Institute) is a division of the Arizona Telemedicine Program. Construction of its new headquarters in Phoenix was federally funded and is located in the Auditorium Building of the former Phoenix Union High School (Figure 1). The Auditorium Building has been renovated to serve as a high tech complex consisting of integrated mixed-function state-of-the art video conferencing facilities as well as a telemedicine training facility (Figure 2).

The Auditorium Building video conferencing complex has three components: a large first floor auditorium; two video-mediated conference rooms on the second floor; and the T-Health Institute on the third floor. The T-Health Institute houses the T-Health Amphitheater and telemedicine training rooms. The video conferencing rooms on all three floors are all linked together by interactive video and can function as an integrated multi-site video conferencing unit.

The T-Health Institute plans to use the Auditorium Building's video conferencing facilities as: (i) a cutting edge video conferencing facility, (ii) a demonstration center for the latest advances in interdisciplinary education, distance education and telehealth

Figure 1. Historic Phoenix Union High School Buildings were recently renovated to house several organizations including the University of Arizona College of Medicine Phoenix Campus and the Institute for Advanced Telemedicine and Telehealth (T-Health Institute). The Auditorium Building, shown in this figure, dates back to 1912. The front neo-classical facade incorporates six white columns. The T-Health Institute is located on the third floor in the front of the building, behind these columns and the five gated horizontal windows. The outside stairs at the front of the Auditorium Building enter at the second floor level (see Figures 2 and 3).

technologies and methods, and (iii) cognitive psychology laboratories to be used for education research (Krupinski et al., 2006).

Figure 3, provided courtesy of Smith Group, Inc., shows a concept rendering of the second and third floors as seen in a frontal perspective of the Auditorium Building. Figures 4A and 4B show additional concept renderings of the T-Health Institute at the third floor level of the Auditorium Building.

The T-Health Amphitheater was designed to maximize the level of video presentation flexibility and interactivity. Seventeen student desks are embedded into three long benches built-in at three levels. Fully controllable theater style lighting fixtures are ceiling mounted to assure adequate lighting on all participants (Figures 4C, 4D).

A key component of the T-Health Amphitheater is a 2 × 6 video cube wall consisting of 12, 50″ Toshiba Video Cubes each capable of 1024 × 768 resolution, resulting in a combined resolution for the video wall of 6144 × 1536 pixels. The video wall is controlled by a Jupiter Systems Fusion 960 Display Wall Processor. The Fusion 960 will allow the wall to display fully moveable and scalable images from multiple PC, video and network sources. A free standing Wharton Lectern with a Crestron control panel will be utilized by session facilitators to control video wall scenarios and access the PCs in the participants' laptop garages. A tabletop videoconferencing unit is located in the T-Health Amphitheater-embedded HIPAA-compliant telemedicine consultation room for case previews by faculty members and students (Figure 4B). A dedicated control room houses all T-Health Amphitheater audio and video switching equipment.

The T-Health Amphitheater audio-video system was designed to facilitate the aggregation of ad hoc in-the-room electronic interdisciplinary teams. In the example illustrated

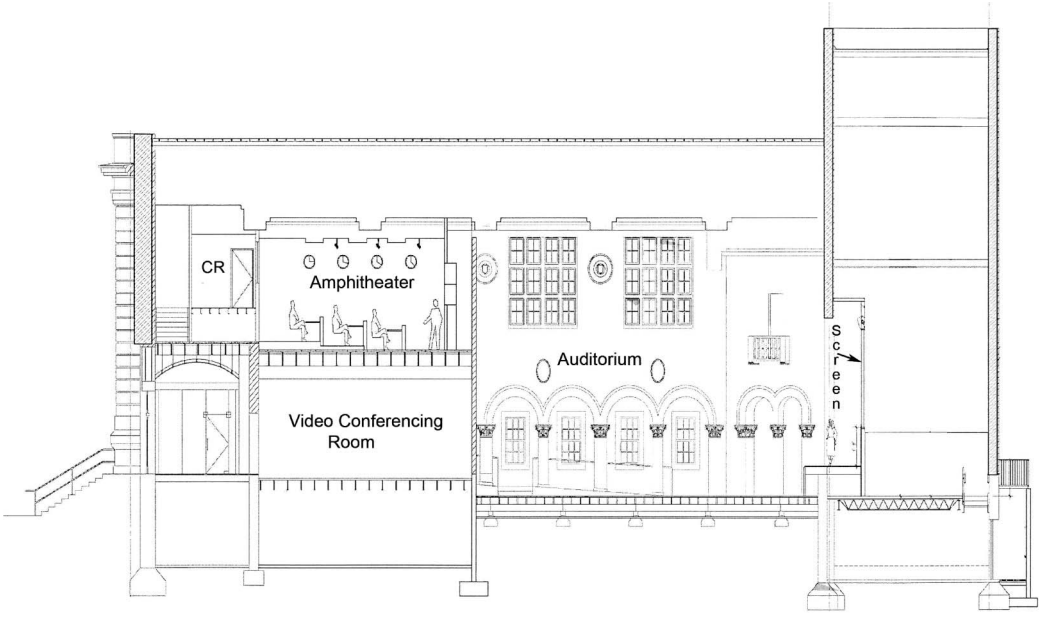

Figure 2. Diagram showing an off-center cross section of the Auditorium Building. The entrance stair case (left) leads into a lobby. Immediately above the mediated class rooms (Video Conferencing Rooms) and the lobby, is the third floor T-Health Amphitheater of the T-Health Institute. As shown in this rendering, students sitting in three rows of seats face a facilitator who is standing in front of a video cube wall in the amphitheater. At the back of the amphitheater is a dedicated control room (CR) where an engineer (not shown) coordinates the media functions of the T-Health Amphitheater. Cognitive scientists, and other specialists with interests in team building, to be seated in the second floor video conference rooms, will be able to actively monitor the interprofessional student team interactions in the third floor T-Health Amphitheater. In this way, the T-Health Amphitheater and the linked Video Conferencing Rooms function as a human performance laboratory. At the right is a 250 seat auditorium with flexible seating. At the far right is a rear-projection room for the 12 foot by 32 foot screen at the front of the auditorium. We envision audiences of health care professionals observing, by video conferencing, the various combinations of instructional and education research activities taking place in the T-Health Amphitheater and the video mediated classrooms.

schematically in Figure 5, 12 personal video camera images are fixed on 12 of the 17 participants occupying amphitheater seats. Each of the participants will have individual headphones and microphones. The plan is to display each of their individual video images, in group-specific clusters, on the video wall. Personal voice channels will be clustered according to the placement of the individual images in the specific groups on the video wall. For interprofessional health care student training sessions, it will be possible to display multiple ad hoc ''electronic groups teams'' on the video wall at the same time. The audio-video system will facilitate the easy reconfiguration of the electronic groups, viewed on the video wall. For example, the individual students can be switched into, and out of, various electronic groups by the faculty facilitator in real time. When a participant is reassigned to a different electronic interdisciplinary student group, his or her individual audio channel will be automatically relocated to the new group's shared audio channel. This makes it possible for participants to sequentially join into a series of small group activities during interprofessional group training sessions. The small groups can, in turn, be merged into larger electronic groups. This is an example of ''in-the-room'' video conferencing.

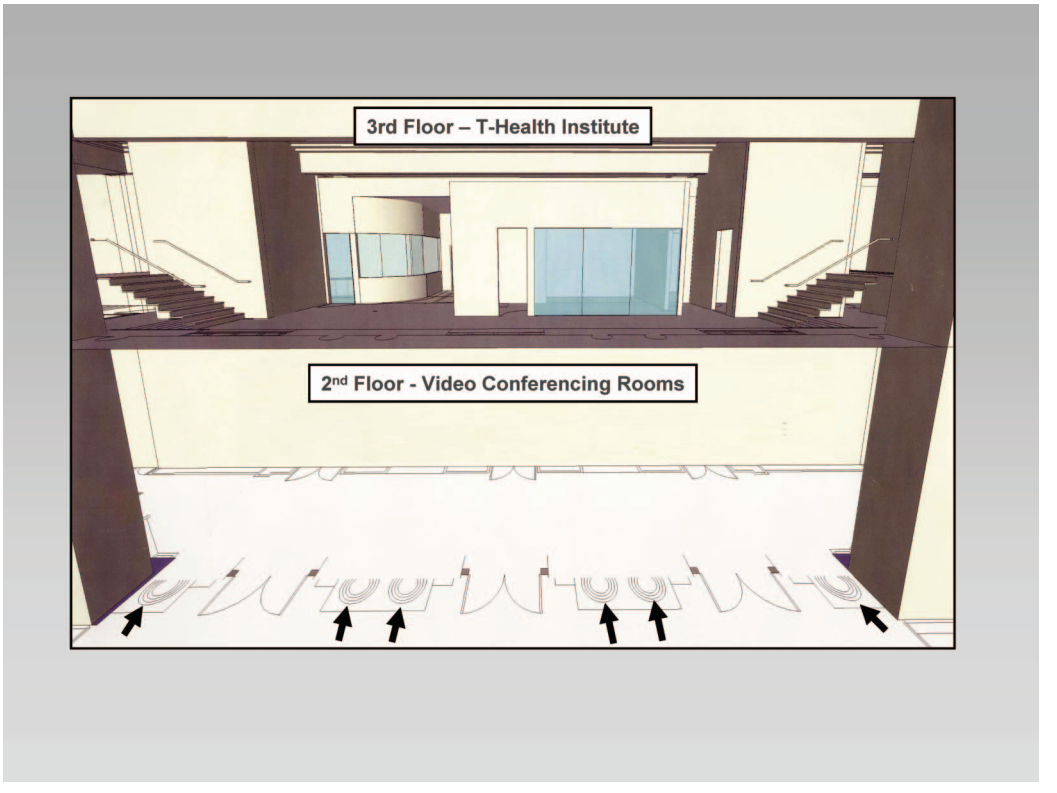

Figure 3. Concept rendering showing a front view of the Auditorium Building with the front wall removed. As points of reference, positions of the footprints of the six white columns located outside the front wall (Figure 1) are indicated with arrows. The front doors of the Auditorium Building lead into a lobby and two second floor Video Conferencing Rooms. The third floor houses the T-Health Institute. From left to right at the third floor level are: a landing at the top of the second floor stair case leading down into the hallway of the T-Health Institute; the curved wall of the T-Health Amphitheater; a third floor Telehealth Video Conferencing Room (flat glass window-wall), doors leading into a Telemedicine Training Suite (right), and a second stairway (right) leading up to the other landing and then back down to the second floor lobby (based, in part, on unpublished drawings by R. S. Weinstein and R.A. McNeely). The concept rendering is courtesy of SmithGroup, Inc., Phoenix, Arizona.

We plan to use the T-Health Amphitheater for formal studies of group dynamics within interprofessional teams. For example, in Figure 5, four medical students (as in ''Group 1''), four nursing students (as in ''Group 2'') and four pharmacology students (as in ''Group 3'') occupy 12 seats. The four participants in each group might initially participate in a discussion in their discipline-specific group. Figure 5 (middle) and Figure 5 (bottom) show the ''electronic swapping'' of a student in Group 1 (along with an audio channel, not shown) into Group 2 and a student in Group 2 (along with an audio channel, not shown) switched into Group 1. It is envisioned that as students go through patient scenarios, the students from the various professional disciplines will have the opportunity to experience thinking about patients in the context of teams of patient service providers, develop interdisciplinary care management plans, and come to understand the relevance of the content of each of their respective disciplines. An objective is for health care students to gain a more global view of the knowledge and skill sets to be mastered within each discipline. Obviously, this approach can be applied to the training of many additional categories of health care workers and is applicable to non-medical fields as well.

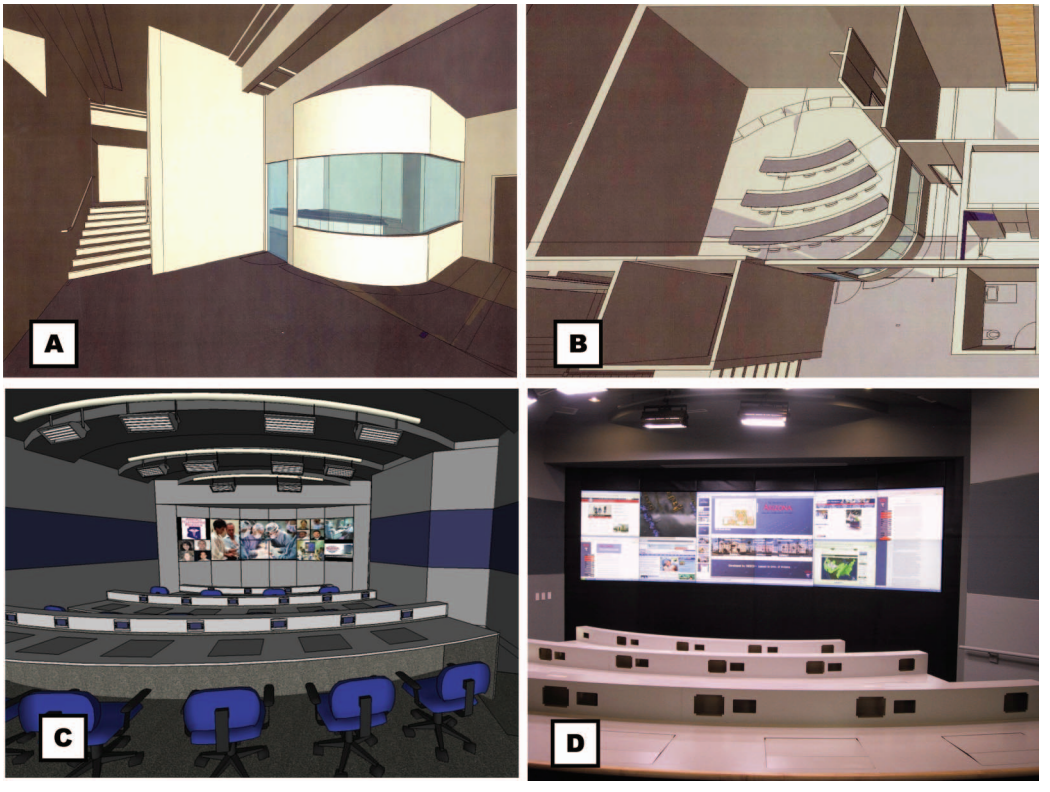

Figure 4. *Upper left (A)*: Concept rendering of the T-Health Institute's hall including its entrance from a high landing (left), the outside wall of the T-Health Amphitheater engineer's Control Room, and the entrance and curved outside wall of the T-Health Amphitheater. The amphitheater is designed so that observers in the hall can view activities in the amphitheater, listening over an audio system, or the windows can be curtained for privacy, when the students and faculty are interacting with off-site telemedicine patients at clinics from around the state. *Upper right (B)*: Concept rendering of the T-Health Amphitheater and its Control Room (bottom, left). The T-Health Amphitheater has three benches and 17 seats facing a large video wall (shown as cubes). At the top-right in the Amphitheater is the telemedicine room where the session facilitator can interact with a patient in private. *Lower left (C)*: Detailed drawing of the T-Health Amphitheater. The dark rectangle on each student desk is the lid of a PC-garage. Upon activation by the facilitator at a podium, individual PC-computers lift out from the desks. Thus, the facilitator is in control of Internet access on an individual student basis, as the groups move through clinical scenarios. *Lower right (D)*: Photograph of the T-Health Amphitheater video cube wall displaying multiple off-campus video feeds. The video wall measures 5 feet × 24 feet. Figures 4A, 4B, and 4C are courtesy of SmithGroup, Inc. Figure 4D is courtesy of Keven Siegert.

Although the example in Figure 5 is used here to illustrate the swapping of medical and nursing students into and out of the "electronic groups" displayed on the video wall, the content that can be imported onto the video wall from off-campus sites is vast and can be tailored to the needs of many different types of learning groups. In the area of health care education, the content may include:

- Live telemedicine cases from off-site rural and urban clinics
- Real-time on-site and off-site video lectures
- Web-streamed lectures
- IP-video cameo presentations by researchers directly from their off-site laboratories

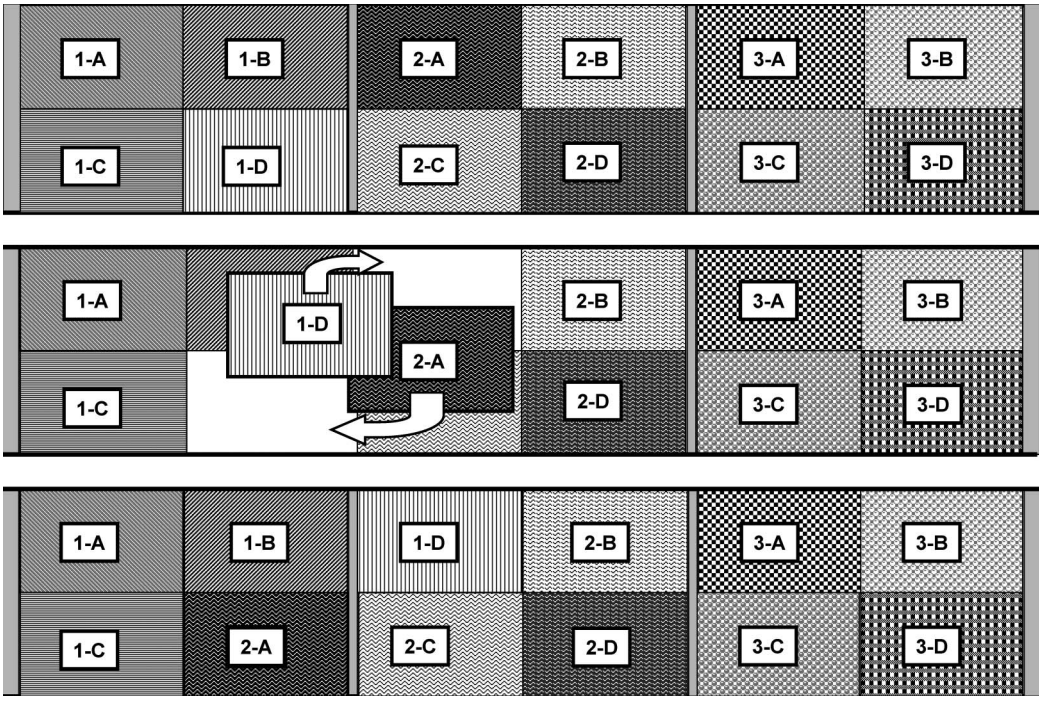

Figure 5. Schematic illustrations of the formation of ''electronic groups'' on the video wall in the T-Health Amphitheater. *Top*: In this illustrators drawing, areas on the video wall are occupied for three groups of participants (1 to 3), displayed on the video cube wall. Group 1, with participants ''A'' though ''D'' are shown on the left. Group 2 and Group 3, each with an additional four participants, are shown in the center and to the right. *Middle*: Artist rendering of the click-and-drag reassignment of Group 1/Participant D into Group 2 and Group 2/Participant A into Group 1. *Bottom*: Reconstituted Group 1 (left) and Group 2 (center) after the electronic swapping of participants 1-D and 2-A is complete.

- Broadcasted lectures and group discussions from national and international meetings
- Health care-related hearings at the State Legislatures and the US Congress
- Archived materials from participants' personal electronic education portfolios (Weinstein, et al., 2005)

Interprofessional training in the Arizona Telemedicine Program experimental curriculum

The Arizona Telemedicine Program is actively involved in many aspects of distance education (www.telemedicine.arizona.edu). A component of an Arizona Telemedicine Program experimental curriculum (code name: ''Institute of Medicine-Plus Curriculum''), being developed at the T-Health Institute, involves interprofessional education. There are many challenges.

Figure 6A shows medical students, nursing students, pharmacy students, and public health students in separate silos. Figure 6B and 6C reflects experiences in which attempts to bring discipline-centered silos together either failed at the outset or tended to fragment with time. As a new strategy aimed at altering counter productive group dynamics, our Arizona Telemedicine Program experimental curriculum incorporates individuals from a wide

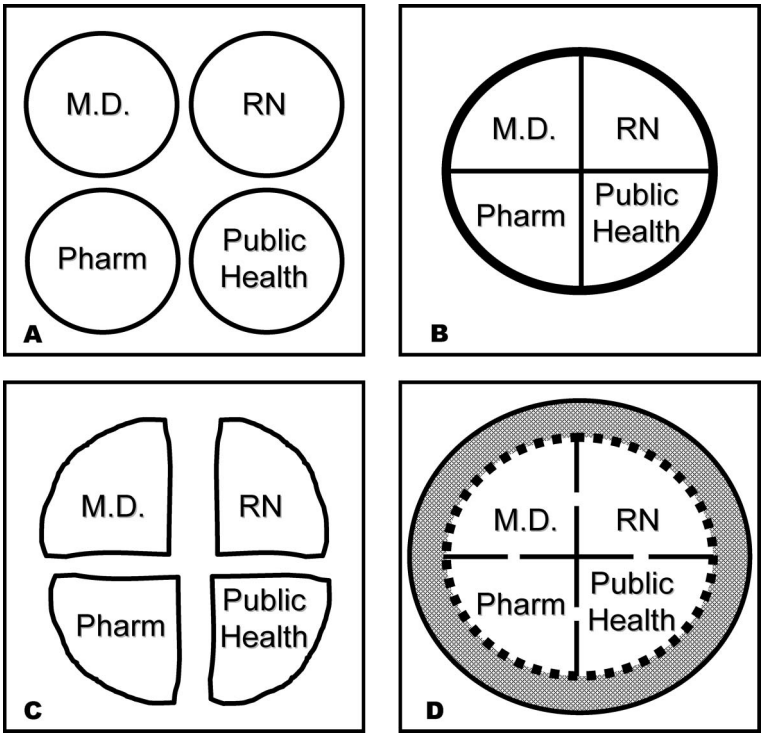

Figure 6. Schematic illustrations of several aspects of interprofessional training. (A) Four discipline-specific silos or tracks, without cross-over. (B) Juxtaposition of four discipline-specific tracks. In our experience, it is challenging to sustain such an arrangement. (C) One outcome of efforts to create interprofessional training modules has been dissolution of the programs, often after one or two sessions. (D) Juxtaposition of four discipline-specific tracks, along with community partners diagrammatically illustrated as a wrap-around. It is hypothesized that the combined use of ''Hollywood Squares'' in-the-room video technologies and the involvement of community partners may minimize the communications barriers between the health care disciplines. These elements are being incorporated into the Arizona Telemedicine Program experimental curriculum design.

assortment of health-related areas, illustrated here as a thick layer around the primary discipline-centered silos, as adjunct participants in some of the team training sessions (Figure 6D). The rationale for this comes, in part, from our experiences with telemedicine video conferencing which suggests that adding non-student stake holders, either in person or ''electronically'', may beneficially alter the learning environment and increase the quality of the interchange among individuals from various disciplines. We hypothesize that this participation of ''outsiders'' will decrease the overall resistance to interprofessional interactions among students and improve the quality of the interprofessional team learning experience (Figure 7). Much remains to be done to validate these ideas.

Discussion

The United States' IOM is concerned about health care quality issues and has focused attention on a perceived need to expand and improve the training of interdisciplinary teams. The IOM has recommended that centers be created to address this need (Greiner & Knebel, 2003). However, this IOM recommendation may meet many obstacles to its

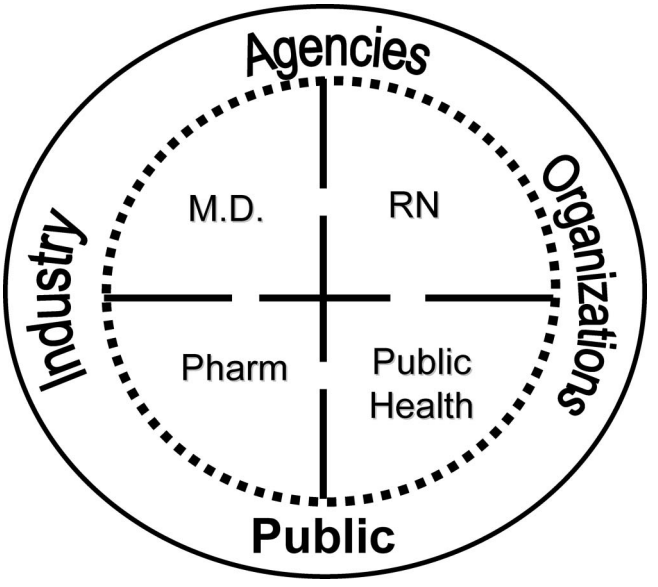

Figure 7. Detail of the Arizona Telemedicine Program experimental curriculum concept illustrated in Figure 6D. Community partner adjuncts may include employees of health care agencies and patients representing various personal and public perspectives.

implementation. Although teaching health care students how to function in interdisciplinary teams, in order to prepare them for careers as interdisciplinary team members, may be a desirable objective, it could be difficult to do on a large scale. There are many barriers, including: the traditional strict separation of health care professions into discipline-specific tracks; issues in authority management within education institutions; logistical issues since the curriculum of medical schools, nursing schools, pharmacy schools, public health schools and others is not coordinated; lack of incentives for most faculty members to work on new health care paradigms; resistance to innovation within the health care professions; and many more (Corser, 1998; Farrell et al., 2001; Horsburgh et al., 2001; Leathard, 2003; McNair et al., 2001; Schofield & Amodeo, 1999; Zwarenstein et al., 2004). The IOM's reports represent a critical first step in the process of re-orienting the health care workforce in the direction of team caring but they do not represent the achievement of a consensus within the health care industry. Eventually, buy-in for re-engineering the health care workforce must extend down to the grass roots of the health care education industry and even the American public. To date, buy-in has been in the form of some important endorsements and the development of a growing number of model programs.

The Arizona Telemedicine Program proposes that distance learning technology could play an important role in addressing the IOM's interprofessional training mandate. The Arizona Telemedicine Program has developed strategies and built new physical facilities specifically for this purpose. We believe that the rate of progress in producing a work force adept in interprofessional team health care delivery might be accelerated by leveraging advances in distance learning technology and video conference facility design in several innovative ways. For example, we suggest that our innovative use of ''in-the-room'' video conferencing might alter the dynamics of team–based learning in ways that may turn out to be beneficial. While it is true that an inherent limitation of video conferencing is its masking

of certain affects and reactions of participants, and that the video media itself creates a somewhat artificial environment, we are attempting to leverage those very limitations into a more effective interprofessional student team learning environment and to formally study the outcomes. Is it possible that it's easier to communicate with someone physically present at one's elbow by in-the-room video conferencing under certain circumstances?

Arizona Telemedicine Program staff have won five national awards from the United States Distance Learning Association for innovations in distance learning programming over a telemedicine network. The staff are especially interested in exploring new uses of video conferencing technologies for health care education. Our innovative in-the-room video conferencing strategy grew out of some interesting observations made by the Arizona Telemedicine Program's professional staff members during many years of experience with video conferencing.

The Arizona Telemedicine Program team observed that, for some participants, video conferencing seems to create a more neutral environment as compared with the individuals' perceptions of in-person meetings. Some people find interacting by video conferencing noticeably less challenging than participating in face-to-face discussions with new acquaintances. During video conferencing sessions, participants may be more willing to be proactive contributors to the dialogue and to challenge authority. In this regard, it may be noteworthy that although multi-site video conferencing is intrinsically hierarchical, this may turn out to be a benefit of the technology for training applications. For example, typically during video conferencing, only one participant is able to speak over the audio system at any one time. This promotes the queuing of speakers which can be especially helpful in groups with traditional ''pecking orders''. This notion of using electronically mediated queuing as a training tool for health care education has not been rigorously studied to the best of our knowledge. On the other hand, we have done thousands of user satisfaction surveys for the Arizona Telemedicine Program distance learning programs and documented a high level of user satisfaction with the programs.

These observations and experiences, and others along these same lines, led us to ask several fundamental questions relevant to interprofessional team training:

- Could in-the-room video conferencing technology be used to minimize the interpersonal issues imposed by the usual discipline-specific communications barriers that are experienced within interprofessional teams? And,
- Could in-the-room video conferencing be used to improve the overall effectiveness and efficiency of interprofessional team training?
- Because off-site participants can be readily inserted into ongoing team training sessions in the video-enabled T-Health Amphitheater, by video conferencing over the Arizona Telemedicine Network, we posed an additional question:
- Can electronically embedding ''stakeholders,'' such as people with other jobs and perhaps even patients, improve the interpersonal interactions within student teams and favorably affect the outcomes of interprofessional student training sessions?

The design of the T-Health Amphitheater in Phoenix, as described in this paper, will enable us to study these questions in a systematic way.

Although the examples in this paper involve the interprofessional training of medical students, nursing students, pharmacy students, and public health students, the T-Health Amphitheater will be used for team training of many other combinations of health care workers, including case managers, social workers, and hospital administrators as well. Federal health care professionals from the Phoenix Area Indian Health Service and the US

Department of Defense, as well as international collaborators, will be among the early users of the T-Health Amphitheater. These federal and international partners of the Arizona Telemedicine Program will participate in the development of the training modules because federal institutions in the United States are already leaders in their uses of interprofessional teams for health care delivery.

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