AVIATION EDUCATION FOR FUTURE PILOTS: AN INTEGRATED MODEL

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Over the past few decades, the surplus of Vietnam era trained pilots has been a major factor in determining military pilot training requirements. The airline industry, likewise, has relied upon the military for its primary source of experienced pilots. However, with these Vietnam era pilots now approaching retirement age, coupled with recent low military pilot training production rates, the United States faces a potential shortage of highly experienced pilots in both the military and the commercial airline industry. While programs have been developed to meet these shortfalls with increased training, consideration should also be given to improving the aviation education which is the foundation of flight training. In spite of the rapid evolution in the sophistication of modern aircraft, and the increased complexity of the flight and navigation environment, the aviation education process itself has changed very little over the years. This paper, which resulted from research conducted in the Aeronautical Management Technology Department at Arizona State University, addresses potential educational enhancements through the implementation of an integrated aviation learning model, the *Aviation Education Reinforcement Option (AERO)*. The AERO model incorporates elements of the adult education paradigm, learning style theory, cooperative and collaborative learning techniques, and personal computer-based flight simulator programs, as a bridge between the classroom and the flight line. While this model focuses on a teaching strategy to improve retention and application for aviation education, it can also be applied to technical education in any learning environment.

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INTRODUCTION

Over the next 15 to 20 years, the United States faces a potential shortage of highly experienced commercial pilots for the airline industry. Although a United States Department of Transportation Federal Advisory Committee study in 1993 highlighted this problem, little has been done to address, as part of the solution, enhancing academic training to substitute for some of the flying hour experience currently required by the airlines. A study was conducted in the Aeronautical Management Technology Department at Arizona State University East to address potential educational enhancements for aviation academics (Karp, 1996). This study was focused on helping to relieve the pilot shortage by preparing pilots to assume commercial air-carrier duties with few flying hours than the airlines currently require. The study was also conducted with an eye toward the academic restructuring potentially being used in military pilot training to improve the long-term retention of complex systems and procedures, as well as the application of the knowledge transfer across a broader spectrum of aviation situations.

In regard to possible modifications to aviation academic programs, the literature suggested that the recognition and adoption of adult learning theories, including adult motivation and facilitation; cooperative and collaborative learning techniques; computer-based learning; and learning style theory could offer potentially valuable academic enhancements to aviation education. The study sought to qualitatively identify the aviation academic program enhancements and the educational restructuring by interviewing and observing aviation students and interviewing flight training providers and potential airline employers.

An initial academic model was developed as a result of the interviews and observations. An evaluation of that model was conducted to test the value the restructured academic education to a class of commercial airline focused university flight students. This paper, which is an outcome of the evaluation of the initial model, proposes an integrated aviation learning model as a bridge between the classroom and the flight line. While this model focuses on a teaching strategy to improve retention and application for aviation education, it also has the potential to be applied to technical education in any learning environment.

THEORETICAL UNDERPINNINGS

Adult Learning

While the term “adult learner” is normally thought to include persons seventeen or older who are not enrolled full-time in high school or college, the term adult learner in its broadest sense applies to every adult participating in organized education (Cross, 1979). Adult learning involves many concepts such as life span, maturation, adult experience, and self-directed learning. Many of life’s events and transitions which adults encounter are unique to adulthood and systematic learning must be developed accordingly (Merriam & Caffarella, 1991). Additionally, there is a strong link between an adult’s motivation to participate in a learning activity and the adult’s life experiences and developmental processes. An understanding of cognitive factors, and how they differ for adults and relate to their experience, is also important in adult education.

Learning involves reflectively transforming the beliefs, attitudes, and emotional reactions that comprise individuals’ meaning schemes. Under the transformative learning theory, the adult educator helps the learner to focus on and examine the assumptions that underlie their beliefs, feelings, and actions; assess the consequences of those assumptions; identify and explore alternative sets of assumptions; and then test the validity of assumptions through reflective dialogue (Mezirow, 1991). Aviation educators at the university level, for example, must perform these very important functions, in addition to their roles as classroom instructors, process facilitators, academic counselors, and administrators of the educational programs. Consequently, adult learners must take upon themselves some of the responsibility for the educational process.

Self-learning is an essential component of adult education; research has shown that adults are perfectly capable of acquiring skills, knowledge and self-insight on their own (Zemke & Zemke, 1995). In aviation education, the extensive amount of technical material that must be covered for the course, and the limited time available in the classroom, requires that every moment of educator-learner exposure be maximized. Aviation educators must assure that students understand the importance of pre-class preparation and then facilitate the students' self-learning process. For students to be successful as self-learners, they must have the internal motivation to achieve that goal.

Adult Motivation

An important area to take into consideration in planning adult education programs is the learners' motives. The most important perspective in adult learning motivation is that adults are voluntary, practical learners who pursue education for its use to them. If education is to serve this voluntary learning force, then educators need to understand what to do to motivate their particular learners (Knowles, 1980). Studies indicate that adult learners appear to be very responsive and motivated to action-oriented learning, that is, learning while doing (Cross, 1979). While action-oriented learning has the potential to be particularly applicable in aviation education, all learners may not be motivated to the same level because of their stage of maturity.

While we generally think of a group of individuals going through an adult education process as being relatively homogeneous, a series of transitional "passages" are being experienced over time by the different members of the group (Sheehy, 1985). Young adults in college, for example, demonstrate a very gradual and progressive identity formation over the course of four to five years. Individuals will most likely go from having self-doubts and lack of confidence at the start, to feeling a surge of competence and personal power by graduation time. During the students' education process, the teacher's motivational approach will certainly have to also change accordingly to the age-stage and maturation of the college student -- moving from mostly a traditional, competitive model of instruction in the beginning, to cooperative, facilitating education towards the end. Successfully facilitating an evolving aviation education learner group requires not only an in-depth knowledge of learning theories, but also an understanding of which age-stage and maturity level the learner group is in as well.

Adults who are motivated, and see a need or have a desire to learn something new, are quite resourceful. The key to using adults' natural motivation to learn is tapping into their most teachable moments: those moments in their lives when they believe that they need to learn something different. The idea of this window of opportunity for learning applies not only to peoples' motivation to learn, but also to their ability to retain what they do learn. In contrast, if the learners acquire a new skill or knowledge, but then have no opportunity to use it or are delayed in using it, the skill or knowledge will fade. Although immediate utility is most often the motivation behind an adult's learning efforts, it is not the only motivation. The evidence also suggests that adults more readily engage in job-skills training and learning if they see it as increasing, or maintaining, their sense of self-esteem and is relevant to the rest of their lives as well as their immediate future (Zemke & Zemke, 1995). In addition to motivation, successfully facilitating an evolving learner group is essential for the aviation educator to assist the learners achieve their desired educational goals.

Adult Education Facilitation

Noted adult educator Stephen Brookfield (1989) maintains that there are six principles of adult education facilitation which should be considered: First, adults voluntarily participate in the educational activity, and as such, the decision to learn is the learners'--they cannot be forced to learn. Second, there must be a mutual respect between the learner and the educator. Third, there must be a collaborative spirit in determining the course objectives, learning methods, and the evaluative process. Fourth, there must be a continuous process of investigation and exploration of the subject matter. Fifth, time must be allotted for critical reflection. And sixth, the education must be self-directed by the learners, with the facilitator assisting the adults to reach their educational goals.

Although much of adult learning is self-directed, the classroom learning environment is still the critical link. Lecture alone is effective and essential when the learners have little or no knowledge of the subject matter. However, facilitation is more effective than lecture when the goal is to engage learners in setting objectives, to tap into their prior experience and knowledge, or to help participants reach a consensus. In regard to effective facilitation, Zemke and Zemke (1995) offer eight guidelines: First, establish goals and clarify expectations for both the participants as well as the facilitator. Second, give up the need to be in control of the group. Third, use questioning techniques to provoke thinking and stimulate recall. Fourth, understand that adults consider themselves at risk in the classroom by demonstrating new behavior in front of peers. Fifth, balance the factors that make up the learning event -- presentation, questions, and discussion. Sixth, draw on the participants' experiences. Seventh, provide feedback and reinforce participants for their contributions and accomplishments. And finally, promote understanding and retention. In this factor, Zemke and Zemke stress that techniques such as breaking participants into small learning groups to exercise new skills and knowledge in relative safety are critical to understanding and retention. Participants in an adult learning process are normally hesitant to try out new knowledge and skills in front of others. Small "praxis" teams that practice and reflect can overcome the reluctance to risk.

Cooperative And Collaborative Learning

In parallel with praxis teams and adult education, cooperative and collaborative learning techniques appear to be particularly applicable for aviation students. In *cooperative learning*, the students participate in small, structured group activities as they work together to solve problems assigned by the educator. The instructor moves from team to team, observes the interactions, listens to the learners' conversations, and intervenes when appropriate. By contrast, *collaborative learning* assumes that the students are responsible participants who already use social skills in completing tasks, and therefore, the students receive less class instruction on group dynamics than in cooperative learning. In collaborative learning, the students are asked to organize their joint efforts and negotiate, among themselves, who will perform which task. The instructor does not always actively monitor the groups and refers all substantive questions back to them for resolution (Bruffee, 1995; Matthew, Cooper, Davidson & Hawkes, 1995). Cooperative and collaborative education, when used with computer tutoring programs and personal computer flight simulator programs to facilitate the learners in teams "teaching each other," has a high potential for enhancing aviation education.

Computer-Based Learning

Technological innovations and computer-based learning can be easily integrated and adopted for higher education (Green & Gilbert, 1995). With the increased access to computer-based tutoring programs, students are moving away from passive reception of information to active engagement in the acquisition of knowledge (Kozma & Johnston, 1991). Computer programs for tutoring technical subjects can be particularly useful in aviation education. Computer-Based Training (CBT) programs can be used extensively for pre-class preparation, as well as post-class review and reinforcement. CBT programs allow the student to accomplish self-paced learning in a non-threatening environment. Learners can also practice, as well as take, the Federal Aviation Administration knowledge examination tests on these computers.

In addition to supporting the CBT programs, the same basic computer equipment can be augmented with a control yoke and throttles to be used with personal computer-based flight simulator programs. These personal computer-based flight simulator programs are relatively low-cost training vehicles that can be easily, and effectively, integrated into an aviation education curriculum. They are well suited as an educational bridge between the basic, traditional aviation classroom and the advanced, high technology aviation flight environment. The flight simulator programs are especially complementary at the university level because they are easily operated, reasonably priced, readily obtainable, and flexible enough for any aviation education curriculum (Karp, 1996). Additionally, personal computer-based training and flight simulator programs help provide the educational components in multiple learning styles, thereby meeting more individuals' learning needs than is provided by classroom lecture alone.

Learning Style Theory

In addition to the major learning theories, learning style theory, that is, the way people learn best, is of considerable significance in developing and delivering academic programs.
One model suggests that there are three recognized primary, or dominant, learning styles: First, *visual learners*, who learn best by reading or looking at pictures. Second, *auditory, or aural, learners*, who learn best by listening. And third, *hands-on, tactile, or kinesthetic learners*, who need to use their hands or whole body to learn (Filipczak, 1995).

In developing educational programs, it is important to know how people learn the best, and why they succeed. Because of the depth and complexity of the subject matter, aviation instructors must present the course material in ways that satisfy the different needs and styles of aviation learners. Likewise, each student must understand his or her dominant learning style and maintain more focused attention to the information when it is being presented in a teaching style which is not easily compatible with their learning style.

INTERVIEWS AND OBSERVATIONS OF MEMBERS OF AVIATION COMMUNITY

Considering the implications of the theoretical underpinnings, interviews and observations were conducted to identify potential enhancements and restructuring to aviation academic programs. Twenty-one aviation students were interviewed and observed, twenty-three academic providers were interviewed, and twenty-one potential airline employers were interviewed. Using grounded theory analysis of the interviews and classroom observations, the major themes or topics areas that evolved for each group were:

Students

Dominant learning style. Over half of the students indicated that their dominant learning style was hands-on (tactile) learning. The remainder was almost divided between auditory learners and visual learners. Most students did not realize that their most optimum way of learning might have been different from other students.

Preferred instructional style. The large majority of the students stated that they preferred a well-structured lecturer as their instructor. Students who preferred facilitators liked a structured class too, but also stated that they learned best from the interchange within the class. Additionally, students liked handouts in advance to “know where the next class was going and what was expected” of them.

Use of high technology equipment in the classroom. Almost 90% of the students indicated a desire to use computer flight simulators with computer projectors in the aviation classroom because they were useful in reinforcing the lecture and the readings by helping visualize what was happening.

Use of teamwork and group projects in the classroom. Slightly over half of the students indicated that they liked teamwork and group projects; however, most of the students did not comprehend the extent to which teamwork skills play in commercial airline aviation.

Academic Providers

Personal learning style. Of those academic providers who could identify their dominant learning style, one-half said that they were hands-on learners and one-half said that they were visual learners. Less than a half of the total interview respondents could identify their own learning style; this could indicate that they might also have difficulty in determining the learning styles of their students.

Obligation to address all learning styles. Almost 40% of the academic providers responded that they did not feel an obligation to address all of the students' individual learning styles. It appeared that providers tended to instruct by using that learning style which aligned with their personal learning style. While this was probably not a conscious effort, it is possible that the providers did not recognize that there were other learning styles or did not consider them important enough to address.

Use of high technology in the classroom. Although almost 85% of the providers felt that the use of personal computer-based flight simulator programs was important. Those providers who were negative about their use in the classroom felt that there was not enough time to learn the programs or to present them.

Use of teamwork and group projects in the classroom. Over 60% of the providers supported teamwork in the classroom; those who did were most interested in improving the behavioral aspects of crew coordination and group dynamics.

Potential Airline Employers

Commercial aviation industrial motivation. Every potential employer who commented on this topic stated strongly that industrial motivation and in-depth aviation knowledge were the essential employment selection factors.

Use of high technology in classrooms. Most potential employers felt that pilots needed to be exposed to the high technology arena as early as possible in the flight training process.

Use of teamwork and group projects in classrooms. Teamwork was stressed as fundamental in the airlines. One executive said, "We need to teach pilots to be crews, not individual pilots."

EVALUATION OF INITIAL AVIATION EDUCATION MODEL

Using the review of the literature and the data collected from the interviews and observations of flight training students, and the interviews with flight training providers and potential airline employers, an initial aviation educational model was developed. An evaluation of this aviation education model was conducted in a university class of commercial airline focused instrument flight students over a two-semester academic year. The model included elements of adult education principles, competitive learning, cooperative learning, collaborative learning, observational learning, personal computer-based learning, and learning style theory. The evaluation incorporated interviews, classroom observations, and observations of the students in a personal computer-based flight simulator laboratory.

Initial Model Components

Adult Education Principles. In line with the adult education model, goals for learning objectives and the methods for knowledge transfer and evaluation were explained in detail by the educator in order to assure a "buy-in" by the learners to the educational process. After the objectives and process were cooperatively agreed upon, the educator provided the learners with a highly structured syllabus for pre-class preparation.

Competitive Learning. Using the traditional, competitive learning model, a lecture was delivered on each major instrument flight topic. The educator provided a study guide which was aligned with the syllabus to reduce the need for students to takes notes so that they could concentrate on the lecture. The educator used a personal computer-based flight simulator program, with a video projector, to visually reinforce the lessons. Traditional scored tests, as well as non-scored, self-assessment tests, were administrated.

Cooperative Learning. Under the cooperative learning model, the learners, in two-person teams, made classroom presentations on subtopics that were *assigned by the educator*. These presentations served as a review of the topics for the entire class, a reinforcement vehicle for the presenters, and a teamwork environment for the learners to practice their group cooperative and interpersonal skills. The learners also used the personal computer-based flight simulator program with a video projector.

Collaborative Learning. The collaborative learning model was used in both the classroom presentations and the personal computer-based flight simulator laboratories. In the collaborative learning classroom setting, the students taught the class an entire topic *as decided by the learner team*. After the classroom presentations had been completed, the two-person teams participated in collaborative sessions using the personal computer-based flight simulators. In the collaborative learning laboratory, the teams "flew" an entire flight profile with the "pilot-flying" acting as the instructor and *teaching* the "pilot-not-flying." Half way through each flight profile the learners would switch places to maximize the reinforcement of the knowledge transfer.

Observational Learning. In the collaborative learning laboratory, a non-flying team observed the team that was flying (social learning model) and then provided an assessment of the flight when the lesson was completed. This provided direct, peer feedback for the team who was flying, and objective observational learning for the non-flying team.

Learning Style Theory. Throughout the various stages of learning -- educator lecture, learner cooperative and collaborative presentations, and learner collaborative and observational flight simulator missions -- the material was delivered in visual, auditory, and hands-on learning styles.

Evaluation Findings

The following findings detail the students' responses to, and assessments, of the aviation education model in the evaluation, as well as the researcher's observations of the students, (Karp, 1996).

Learning Theories. The students responded very positively to the adult learning paradigm with facilitation and motivation, and a focus on the students buying-in to the course objectives, self-directed study, and cooperative and collaborative learning techniques. Additionally, the learners felt that behavior modeling by the educator in the lectures, as well as the learner-to-learner modeling in cooperative and collaborative session, was very conducive to in-depth knowledge transfer.

Structured Study Guide and Syllabus. The learners provided strong, positive comments on the effectiveness of the highly structured study guide and course syllabus. Students indicated that they felt more inclined to complete the syllabus pre-class preparation assignments since they helped formulate the course objectives (adult learning model) and knew that the study guide would be used in class to take supplemental notes for subsequent review and study.

Lectures. The students were very accustomed to having a lecture followed by individual testing (traditional, competitive). They recognized that in aviation education this learning model is important at the beginning to transfer baseline knowledge when they had little or no experience in their backgrounds on which to rely. Students indicated, however, that they had a tendency during this component to study only what they thought they would be tested on. Under the traditional, competitive learning model, long-range application did not appear to be a primary motivator for most students in the preparation for their classes.

Testing. The students noted that while at first they did not understand at the usefulness of the ungraded tests (adult learning model), once they recognized that these tests were truly for their own self-assessment, they found them very helpful to assess their own long-term retention, as well to prepare for the graded knowledge retention tests (competitive learning model).

Team Classroom Presentations. The students responded extremely well to the cooperative component (social learning model). Once the learners recognized the benefits of team presentations for long-term knowledge retention, most of them wanted more presentations added. Although some students were not always personally motivated to do their best, all students liked this approach. Additionally, most students commented that they wanted to change partners a number of times during each semester to broaden their scope of learning by being exposed to other learners' thought processes.

Team PC-Based Flight Simulator Programs. The students supported this collaborative learning vehicle the strongest. They felt that once they had been exposed to the basic instrument flight information in the classroom, the use of the personal computer-based flight simulator programs was an exceptional reinforcing tool. They added, however, that they wanted more of these collaborative lessons added so that there were longer flight simulator sessions immediately after each class session. Additionally, the learners thought that it would be useful to change teammates frequently during each semester to more realistically simulate the crew changes that take place in commercial airliners. They felt that by exposing themselves to different personalities and learning approaches, their knowledge levels and their interpersonal skills would increase.

IMPLICATIONS FOR AVIATION EDUCATION LEARNING PROCESS

Because of the uniqueness of flight training, aviation education requires a different model than that for the education of young people. Whereas young people expect to be told what to learn and count on the experts to instruct them in what they need to know for some future application, adults want to be able to immediately use the knowledge or skills learned. Research indicates that interactive and active modes of learning are more appealing to most adults that passive listening or watching (Cross, 1979). Normally in aviation education, learning takes place in a series of clearly established, progressive procedures: The student essentially learns *what* the instructor tells them to learn, and performs *how* the instructors tells them to perform, and uses the information or accomplishes the actions *when* the instructor tells them to do so. However, the learners at this early level do not necessarily have much of an in-depth understanding of *why* the information or the actions are important (Karp, 1996).

It is critical that aviation students be able to transfer the knowledge they have acquired to situations that the instructor has not mentioned previously. By understanding *why* actions are taken, and *when* they are taken, the learner can then apply that information to similar situations. In many traditional aviation programs, application of the knowledge does not occur until the student gets into the airplane or into the simulator if one is a component of the lesson. Additionally, there may a significant time lag between the classroom instruction and the flight or simulator application. Finally, most traditional aviation education programs use little, if any, self-direction in the learning process (Karp, 1996). While there are some weaknesses in a traditional aviation education program, there are also some significant strengths in the form of extensive lectures and comprehensive examinations, by knowledgeable, skilled instructors. By combining the strengths of the traditional aviation classroom, with the principles of adult education and learning theory concepts, an integrated learning model can be developed for aviation education curriculum.

VALIDATED INTEGRATED AVIATION LEARNING MODEL

As a result of the evaluation of the initial aviation education model, an integrated learning process, the *Aviation Education Reinforcement Option* or *AERO model* (figure 1), was developed to increase retention and enhance application of aviation education. In addition to the adult learning principles and cooperative and collaborative learning techniques, the model employs extensive use of personal computer-based flight simulator programs to provide immediate application and hands-on training. The model also stresses the use of pre-class preparation and post-class reinforcement through structured reading assignments and computer based training tutoring programs.

There are several keys to the success of such a learning model: The entire integrated aviation learning model must be closely monitored and facilitated by the educator to assure that the agreed upon objectives are met in the desired sequence. Pre-class preparation and self-directed learning are stressed to maximize learner-educator contact time. Handouts are provided so that learners only have to take marginal notes, thus enhancing their attention to the dialogue in the classroom environment. The curriculum must be presented by the educator in all learning styles and in a building-block approach, while using increasingly complex material and technology. In addition to the self-directed learning, interactive, cooperative, and collaborative techniques are important to students learning from each other. The learners should be grouped into teams, or *crews,* for student presentations in the classroom, followed immediately by PC-based flight simulator program lessons in a crew learning laboratory. Learners *teaching* other learners the various components of each lesson contributes significantly to long-term retention. Another team of learners should also observe while the student crew is flying the simulator in the learning laboratory. The behavior modeling of both successful and unsuccessful actions, an outgrowth of observational learning theory, is particularly applicable to university-level aviation education when it corresponds to future job related performance.

CONCLUSION

As aviation technology and the international airspace structure become more complex, aviation students must assimilate, on a high retention and application level, an increasing amount of information. An integrated learning model applied to modern aviation education could improve understanding, efficiency, effectiveness, and safety in aviation education and training programs. Elements essential to the success of an integrated aviation learning model would be: the adoption of adult learning principles, the implementation of cooperative and collaborative learning; the facilitation of the knowledge transfer by highly trained experts to assure in-depth knowledge; the curriculum being addressed in all major learning styles; and the use of computer based training programs to enhance preparation and immediate application. An in-depth academic knowledge is critical in aviation because the success of the training is not measured on the bottom line of a balance sheet like many other professions, but it is measured rather in safety--the protection of the lives of the flight crews and their passengers.

The incorporation of an integrated aviation learning model should not only have a positive affect on the efficiency and effectiveness aviation training programs, but it should also potentially help ease the projected shortage in the major commercial airlines by substituting in-depth, long-term knowledge and proficiency for some of the airlines' current flying hour hiring requirements. Additionally, such an integrated aviation learning model could be used in military pilot training to help enhance long-term retention of academic knowledge, as well as improve application across a broader spectrum of aviation situations.

While this model was developed as a teaching strategy for aviation academic education at the university level, it also can be applied to technical education in any learning environment. The investment in time for curriculum development in such a structured, integrated educational model should pay high dividends in expanding the learners' knowledge base, enhancing their flexibility to address new situations, and increasing their productivity and effectiveness.

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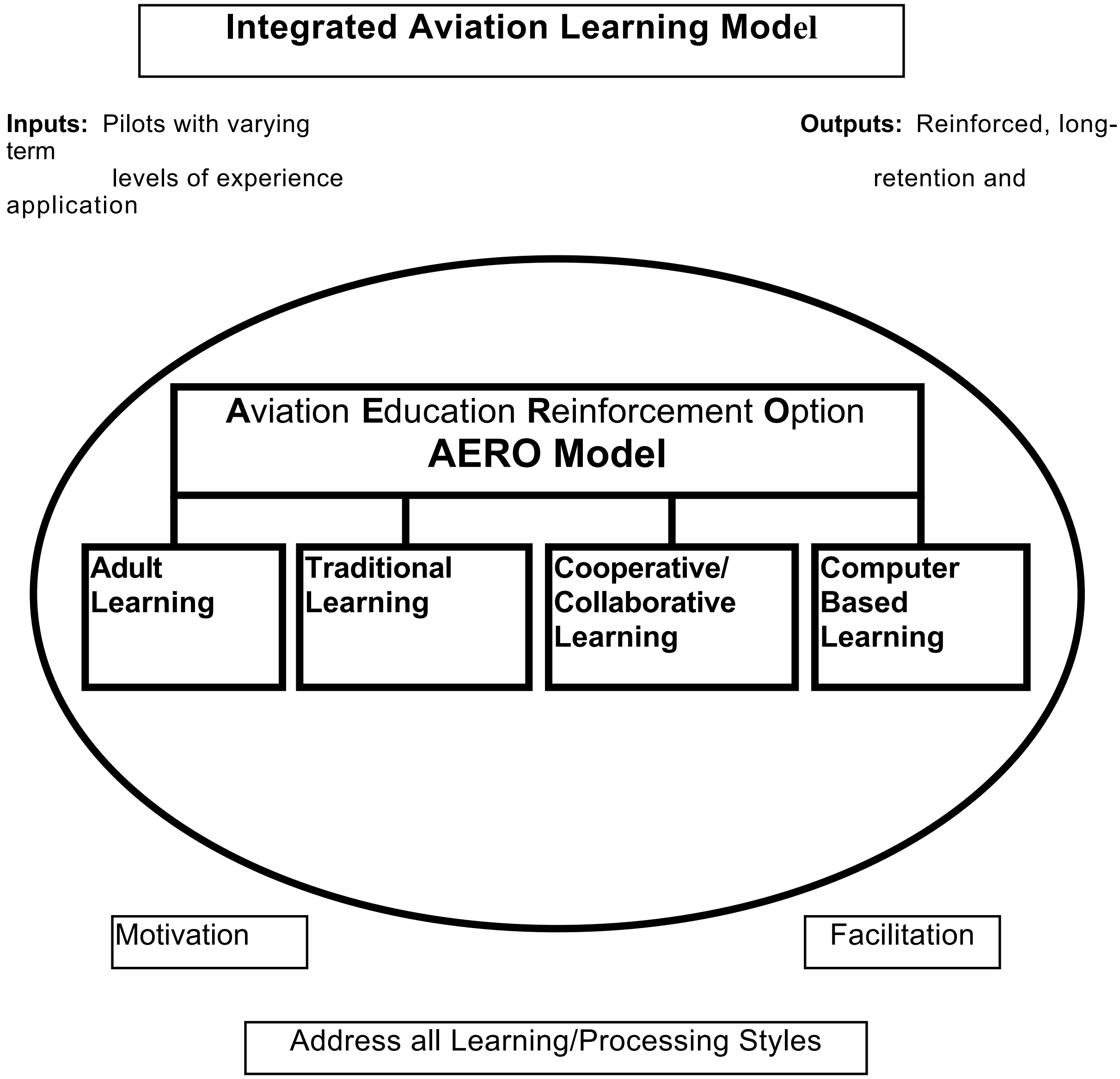

Figure 1. The Aviation Education Reinforcement Option (AERO) Model