Title:

Enhancing Science and Technical Education:
Implementing Learning Style Theory in the Classroom

Author:

Merrill R. Karp, Ph.D.

Affiliation:

Arizona State University East

Address:

Department of Aeronautical Management Technology
7442 E. Tillman Ave
Mesa, AZ 85212

E-Mail Address:

Ron.Karp@asu.edu

October 11, 2002

Topic Area:

Science Education

Key Words:

Science and Technical Education

Phone Number:

480-727-1873

Fax Number:

480-727-1730

2003 Hawaii International Conference on Education
Honolulu, Hawaii
January 7-10, 2003

Enhancing Science and Technical Education: Implementing Learning Style Theory in the classroom

Merrill R. (Ron) Karp, Ph.D.
Associate Professor
Arizona State University East
College of Technology and Applied Sciences
Department of Aeronautical Management Technology

Abstract

The educational process for instructing science and technical subjects is critical for laying the "foundation" for the retention and application. At Arizona State University East, considerable research has been accomplished on "Learning Style Theory" (that is: visual; auditory; and tactile, or hands-on, learning), as well as the inclusion of Learning Style Theory in science and technical education classrooms. An important element of an integrated academic program includes immediate application in, and immediately after, each classroom experience in order to enhance long-term retention of the knowledge transferred. This paper explores the introduction of learning style theories in the science and technical education discipline. The paper will offer a short learning style instrument to help the educator understand how <u>they</u> personally are "hard-wired" for knowledge retention, how the educators can administer this instrument to their classes, and then how the educators can help their students interpret the results. As a result of the research conducted by the author in aviation education, the paper will use this discipline, which is heavily focused in science and technology, as an example of how learning style enhancements can be implemented in the classroom. Additionally, details of a special study on women's learning style research in aviation will be discussed to underscore the need for science and technical education faculty to revisit their academic classroom formats. The investment in time for curriculum development with such a structured, integrated education model with learning style considerations, should pay high dividends in expanding the learners' retained knowledge base and enhancing their flexibility to address new situations.

Enhancing Science and Technical Education: Implementing Learning Style Theory in the classroom

Merrill R. Karp, Ph.D.
Arizona State University East

Abstract

The educational process for instructing science and technical subjects is critical for laying the "foundation" for the retention and application. At Arizona State University East, considerable research has been accomplished on "Learning Style Theory" (that is: visual; auditory; and tactile, or hands-on, learning), as well as the inclusion of Learning Style Theory in science and technical education classrooms. An important element of an integrated academic program includes immediate application in, and immediately after, each classroom experience in order to enhance long-term retention of the knowledge transferred. This paper explores the introduction of learning style theories in the science and technical education discipline. The paper will offer a short learning style instrument to help the educator understand how <u>they</u> personally are "hard-wired" for knowledge retention, how the educators can administer this instrument to their classes, and then how the educators can help their students interpret the results. As a result of the research conducted by the author in aviation education, the paper will use this discipline, which is heavily focused in science and technology, as an example of how learning style enhancements can be implemented in the classroom. Additionally, details of a special study on women's learning style research in aviation will be discussed to underscore the need for science and technical education faculty to revisit their academic classroom formats. The investment in time for curriculum development with such a structured, integrated education model with learning style considerations, should pay high dividends in expanding the learners' retained knowledge base and enhancing their flexibility to address new situations.

Introduction

While modern science and technical education involves highly sophisticated and rapidly evolving concepts and equipment, in an increasingly dynamic environment, the science and technology classroom process itself has, any many cases, changed little over the years. This study examines learning style theory, the transition to adult learning principles, implementing cooperative, collaborative, and observational learning techniques, and the use of computer-based learning programs to reinforce the classroom experience. An integrated learning model (Science and Technology Academic Reinforcement, or STAR Model) is suggested to improve long-term retention and enhance application across a broad spectrum of new situations.

Theoretical Implications

Learning Style Theory

Learning style theory, that is, the way people learn best, is of considerable importance in developing and delivering science and technology 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). If knowledge transfer is to take place within the entire classroom population, then all of these dominant learning styles should be addressed in the academic environment.

An example of learning style research in science and technology education can be found in a recent study conducted in the aviation education discipline (Karp, Turney, Green, Sitler, Bishop, & Niemczyk, 2002). In this study, a learning style assessment instrument (Appendix A) was administered to 390 collegiate aviation student pilots (195 women and 195 men) from representative university and college members of the University Aviation Association (UAA) from around the country. The individual university and college aviation faculty representatives who assisted in the data collection distributed the surveys to <u>all</u> of their female aviation student pilots and a randomly selected equal number of their male aviation student pilots.

Results of Learning Style Research

Women Respondents. Of the 195 women respondents, 112 (57.4%) were either dominant hands-on learners, or an equal combination of hands-on and visual and/or auditory learners (Table 1).

Learning Style	Number	Percentage
Visual (dominant)	62	31.8%
Auditory (dominant)	15	7.7%
Hands-On (dominant)	87	44.6%
Visual/Auditory (equal dominance)	6	3.1%
Auditory/Hands-On (equal dominance)	7	3.6%
Visual/Hands-On (equal dominance)	15	7.7%
Visual/Auditory/ Hands-On (equal)	3	1.5%
Total	195	100%

Table 1. Dominant learning styles of women respondents (n=195)

Men Respondents. Of the 195 men respondents, 118 (60.5%) were either dominant hands-on learners, or an equal combination of hands-on and visual and/or auditory learners (Table 2).

Learning Style	Number	Percentage
Visual (dominant)	56	28.7%
Auditory (dominant)	15	7.7%
Hands-On (dominant)	88	45.1%
Visual/Auditory (equal dominance)	6	3.1%
Auditory/Hands-On (equal dominance)	10	5.1%
Visual/Hands-On (equal dominance)	14	7.2%
Visual/Auditory/ Hands-On (equal)	6	3.1%
Total	195	100%

Table 2. Dominant learning styles of men respondents (n=195)

Comparison of Women and Men Respondents. Comparing the results of the women and men respondents, a picture becomes apparent that women and men in collegiate aviation are very similar in their dominant learning styles. For example, 44.6% of the women indicated that they were dominantly hands-on learners, compared to 45.1% of the men respondents.

A quantitative analysis was performed comparing male and female learning styles (without consideration of equal dominance). For this analysis, each respondent was considered to have a percentage of responses in each of the three categories. Percentages were used because males tended to give more responses than females and so accurate analysis required the use of proportions. A two-sided unpaired t-test was used to compare the male and female responses for each of the three learning styles. The resulting p-values for the visual and hands-on responses showed no significant result at any reasonable significance level. The responses in these two categories were clearly very close. The auditory p-value was .18, which does not show significance at a reasonable level (.05 or .10). However, this does suggest the possibility that males are slightly less auditory than females.

Composite of Women and Men Respondents. Of the total of 390 women and men respondents, 221 (56.7%) were either dominant hands-on learners, or an equal combination of hands-on and visual and/or auditory learners (Table 3).

Learning Style	Number	Percentage
Visual (dominant)	118	30.3%
Auditory (dominant)	30	7.7%
Hands-On (dominant)	175	44.9%
Visual/Auditory (equal dominance)	12	3.1%
Auditory/Hands-On (equal dominance)	17	4.3%
Visual/Hands-On (equal dominance)	29	7.4%%
Visual/Auditory/ Hands-On (equal)	9	2.3%
Total	390	100%

Table 3. Dominant learning styles of both women and men respondents (n=390)

Comparison of Women and Men Respondents to a Previous Study. A combination of the women and men together (Table 3) can be used to compare this study's findings with a previous study to validate the consistency of the results. In an earlier study (Karp, 2000), when examining the learning style assessments over a two-year period of a composite of 117 respondents, from private pilots to F-16 pilots, the research (Table 4) indicated that 58.1% of the pilots were either dominantly hands-on learners, or an equal combination of hands-on and visual and/or auditory learner. When comparing this 58.1% (n=117) to the combined women and men results of 58.9% of this current study (n=390), or the women only results of 57.4% (n=195), a parallel propensity surfaces: Individuals in collegiate aviation, whether they are women or men, are very dominantly hands-on learners and need that "tactile" connection to process and retain knowledge.

Learning Style	Number	Percentage
Visual (dominant)	38	32.5%
Auditory (dominant)	8	6.8%
Hands-On (dominant)	52	44.4%
Visual/Auditory (equal dominance)	3	2.6%
Auditory/Hands-On (equal dominance)	0	0
Visual/Hands-On (equal dominance)	16	13.7%
Visual/Auditory/ Hands-On (equal)	0	0
Total	117	100%

Table 4 Dominant learning styles of both women and men respondents in previous study (n=117)

Impact of Research Results

In spite of this research underscoring that majority of pilots were either predominantly either hands-on learners, or an equal combination of hands-on and visual and/or auditory learners, previous research indicated that most classroom environments are still auditory in nature, with visual supplementation, and very little, if any, hands-on learning applications (Karp, 2000). In this research effort, both women and men indicated that they were similar in their need for more immediate, hands-on application. Accordingly, hands-on learning opportunities must be used to accommodate this hands-on learning requirement if all future pilots are to have their learning environment enhanced. There are a number of science and technical education transfer vehicles, such as, computer based training and laboratory experiments, that can be easily implemented into the classroom or laboratory experience to complement the classroom environment by providing immediate hands-on application.

Computer-Based Training. A valuable tool to assist in hands-on learning in the classroom, in addition to visual and auditory learning, is computer-based training. With the increased access to computer-based tutoring programs, students are moving away from passive reception of information to more active engagement in the acquisition of knowledge (Kozma & Johnston, 1991). Computer programs for tutoring technical subjects can be particularly useful in science and technology education. Computer-Based Training (CBT) programs can be used extensively for pre-class preparation, as well as post-class review and immediate reinforcement. CBT programs allow the student to accomplish self-paced learning in a relatively non-threatening environment.

Laboratory Experiments. Laboratory experiments and exercises are relatively low-cost training vehicles that can be easily and effectively integrated into a science and technology education curriculum. They are well suited as an educational bridge between the basic, traditional classroom, and the advanced, high technology environment (Karp, 1996). However, the key is that laboratory experiments and exercises, as with personal computer-based training helps provide the educational components in multiple learning styles, thereby meeting more individuals' learning needs than are provided by classroom lecture alone.

While learning style considerations are an essential component of the knowledge transfer process, there are other theoretical considerations that should be taken into account when developing an integrated learning model for science and technical education.

Transition To Adult Learning

While the adolescent learning model is comfortable for students moving through the formal secondary education system in the United States, as the students enter higher education institutions they will be faced with a completely different form of knowledge transfer that places more emphasis on self-learning and personal initiative. Faculty in secondary education can help prepare their students' entry into higher education, particularly in the areas of science and technology, by the early implementation of some of the concepts of *adult education* that the students will be encountering as they advance into universities and colleges.

More and more attention has been given in recent years to the application of adult development strategies. It is now recognized that adult development is not simply one long period lasting from the end of adolescence to the time of death, but is a series of developmental periods dependent on a combination of social, biological, psychological, and physiological tasks and functions. This holistic view of adulthood not only has spurred new interest and research by and for educators of adults, but also has generated new practices based on knowledge of adult development and learning (Rossman & Rossman, 1990, p.1).

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 consequently, 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 for transitioning into adult education.

Learning also involves reflectively transforming the beliefs, attitudes, and emotional reactions that comprise individuals' meaning schemes. Under the transformative learning theory, the 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). Science and technology educators at the university level must perform these very important functions, in addition to their roles as classroom instructor, process facilitator, 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. In regard to adult self-learning, Zemke and Zemke (1995) have expanded on the work of Malcolm Knowles (1980) and others to detail the steps adults should take in making the most of their self-directed learning effort: Step one is to become aware that there is something which needs to be learned. Step two is to identify what it is to be learned. Step three is to diagnose the skill or knowledge needed to achieve the goal. Step four is to develop a plan of inquiry and a list of resources. Step five is to begin proactive learning--reading and studying the material and trying an application of the concept. Step six is to evaluate whether the learning objectives have been met. And step seven is to re-diagnose the learning needs and repeat the process as necessary. In science and technical education, the extensive amount of 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. 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

Many of the life events and transitions adults face are peculiar to adulthood and require adjustments--adjustments often made through systematic learning activity. There is a strong link between the motivation to participate in a learning activity and an adult's life experiences and developmental issues (Merriam & Caffarella, 1991, p. 308).

One of the single most important areas to understand in planning adult education programs is the learners' motives. The essential perspective to keep in mind with adult motivation for learning 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. Studies indicate that adult learners appear to be very responsive to action-oriented learning, that is, learning while doing (Cross, 1979). Research in theoretical, technical education has indicated that early involvement in the classroom experience with personal computer-based self-learning programs has a high payoff in enhanced retention and application in most learners (Karp, 1996). While this form of action-oriented learning has been shown to be particularly applicable in technical education, all learners may not be motivated to the same level, depending on their stage of maturity.

While we generally think of a group of individuals going through, or into, 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 progress 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 science and technology 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 know 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 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 science and technology 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: (1) adults voluntarily participate in the educational activity, and as such, the decision to learn is the learners'--they cannot be forced to learn, (2) there must be a mutual respect between the learner and the educator, (3) there must be a collaborative spirit in determining the course objectives, learning methods, and the evaluative process, (4) there must be a continuous process of investigation and exploration of the subject matter, (5) time must be allotted for critical reflection, and (6) 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 work 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 eighth, promote understanding and retention. In this final factor, Zemke and Zemke stress that techniques such as breaking participants into small learning groups to exercise new skills and knowledge in relative safety is critical to understanding and retention. Participants in a learning process are normally hesitant to try out new knowledge and skills in front of others. Small "praxis" teams that practice, reflect, and try again can overcome the reluctance to risk.

In parallel with praxis teams and adult education, cooperative and collaborative learning techniques are particularly applicable for science and technology 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). In *observational learning*, the behavior modeling of both successful and unsuccessful actions, an outgrowth of observational learning theory is particularly applicable to university-level science and technology education Research has indicated that cooperative, collaborative, and observational education, when used with computer tutoring programs to facilitate the learners in teams "teaching each other," has a wide application in enhancing theoretical education (Karp, 1996).

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, science and technology instructors must present the course material in ways that satisfy the differing needs and styles of science and technology learners. Likewise, each student must understand his or her dominant learning and processing styles, and maintain more focused attention to the information which is being presented in a teaching style which is not easily compatible with their learning style

Learning Process

Adult education, which at the university level should be considered to include science and technology education and training, requires a different model than that for the education of children and 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 science and technology 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 instructor 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 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 science and technology classrooms, application of the knowledge does not occur until the student gets into the laboratory, or uses the information on the job, sometime in the future. There may a significant time lag between the classroom instruction and the application. Finally, many traditional science and technology education classrooms use little, if any, self-direction in the learning process. While there are some weaknesses in traditional classrooms, there are some significant strengths in the form of extensive lectures and comprehensive examinations, by knowledgeable, skilled instructors. By combining the strengths of the traditional classroom, with the principles of adult education and learning theory concepts, an integrated learning model can be developed for science and technology curriculum and transfer.

Integrated Learning Model

The *Science and Technology Academic Reinforcement (STAR) model*, at Figure 1 is an Integrated Learning Model designed to increase retention and enhance application of theoretical science and technology education. In addition to the adult learning principles and cooperative and collaborative learning techniques, the model employs laboratory experiments, as well as using personal computer-based training (CBT), to provide immediate application and hands-on training.

There are several keys to the success of such a learning model: The entire integrated 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 is stressed to maximize learner-educator contact time and 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 and processing styles, in a building-block approach, and using increasingly complex material and technology. In addition to the self-directed learning process, the students must be interactively, cooperatively, and collaboratively involved in helping each other learn. The learners should be grouped into teams for the student presentations in the classroom, followed by experiments and exercises in the laboratories. Learners *teaching* other learners the various components of each lesson contributes significantly to long-term retention. Another team of classmates should also observe the learners.

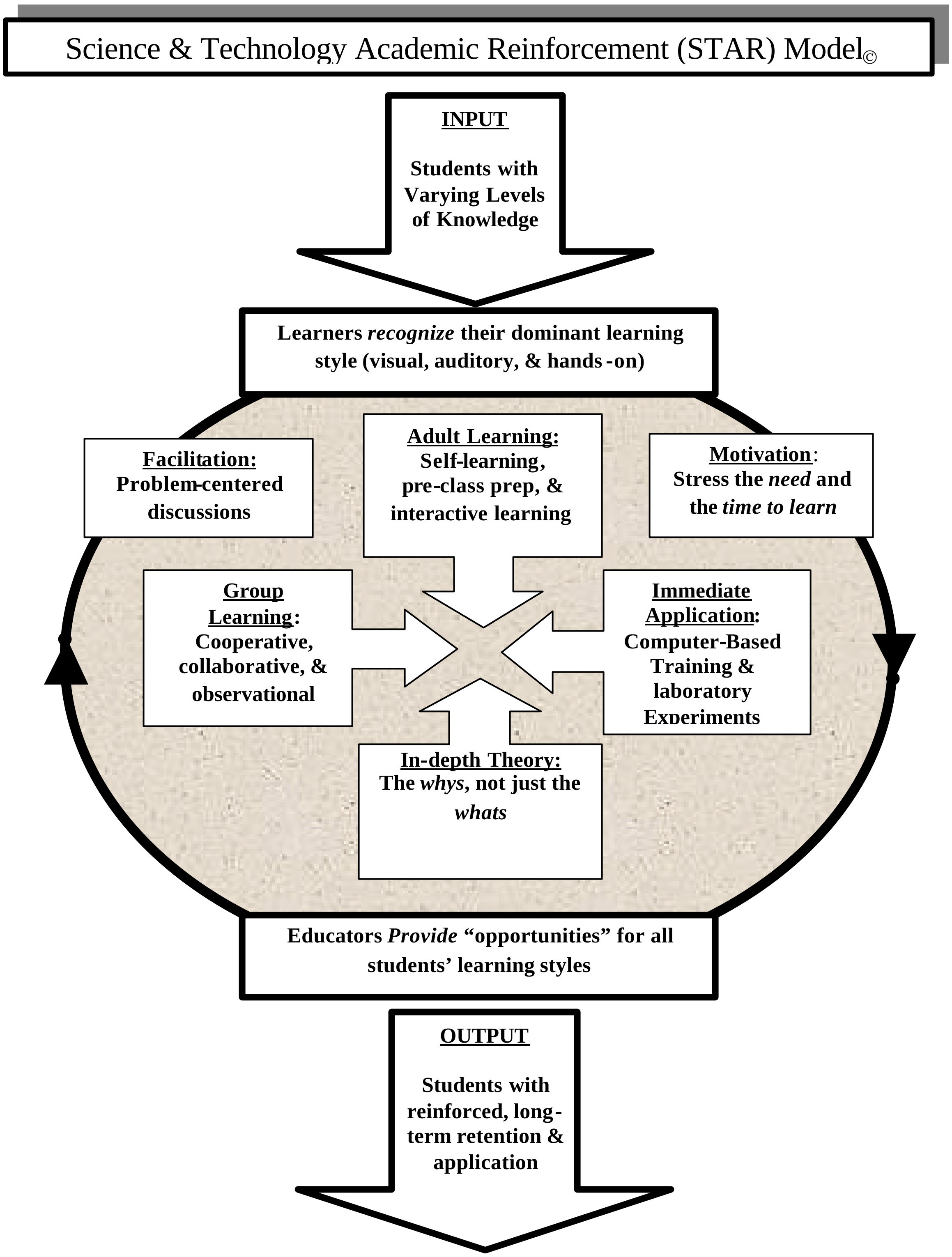

Figure 1: Integrated Learning Model: Science & Technology Academic Reinforcement (STAR) ©

Recommendations

1. Educators should administer to all science and technology students a "quick and easy-to-take" learning style assessment instrument (similar to Appendix A), to help them identify, for themselves, their own dominant learning style. The educator should then facilitate a discussion with the learners on how they might maximize their dominant learning style in day-to-day learning situations (by using an aid similar to Appendix B). Educator's should also determine and consider their own dominant learning styles because research has indicated that many instructors teach in the style that they, themselves, learned best, without thinking about potential differences for their students.

2. Educators should present their science and technology curriculum using all three learning style environments (visual, auditory, and hands-on) so that *all students* have the best opportunity to reinforce the material using their dominant learn style(s). Employing PC-based computer training and laboratory exercises immediately following the classroom experience, is an excellent reinforcing vehicle to provide the hands-on learning opportunities, which are critically, needed by a large number of both women and men science and technology students.

3. Science and technical education educators should implement an integrated learning model (similar to the START model) to improve in-depth understanding and retention of knowledge and enhance application to new situations.

Conclusion

As science and technology become more complex, students must assimilate, on a high retention and application level, an increasing amount of information. Any adult education program whose learning outcome objectives are long-term retention and application of highly technical subjects can easily adapt the STAR model to their specific educational requirements. The key to the success of an adaptation of the STAR model would lie in the facilitation of the knowledge transfer by highly trained experts; the curriculum being addressed in all major learning styles; and the use of computer based training programs to enhance preparation and immediate application. 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.

References

Brookfield, S. (1989). Facilitating adult learning. In S. Merriam and P. Cunningham (Eds), Handbook of adult and continuing education. San Francisco: Jossey-Bass.

Bruffee, K. (1995, January/February). Sharing our toys: Cooperative learning versus collaborative learning. Change, 27, 12-18.

Cross, K. (1979). Adult learners: Characteristics, needs, and interests. In Peterson, R. and associates (Eds), Life learning in America. San Francisco: Jossey-Bass.

Filipczak, B. (1995, March). Different strokes: Learning in the classroom. Training, 32, 43-48.

Karp, M. (1996). Theoretical Aviation Training for Future Airline Pilots. Doctoral Dissertation, Walden University, UMI 9713644. Minneapolis, MN.

Karp, M.R. (2000, October). University Aviation Education: An integrated model. Collegiate Aviation Review, 18, (1).

Karp, M., Turney, M., Green, M., Sitler, R., Bishop, J., & Niemczyk, M. (2002). Retaining women in collegiate aviation: a data-driven model. Proceedings of Aviation Communication Conference, March 3-5, 2002, Mesa, AZ.

Knowles, M. (1980). The modern practice of adult education: From pedagogy to andragogy (2nd Ed). New York: Cambridge Books.

Matthew, R., Cooper, J., Davidson, N., & Hawkes, P. (1995, July/August). Building bridges between cooperative and collaborative learning. Change, 27, 35-40.

Merriam, S. and Caffarella, R. (1991). Learning in adulthood. San Francisco: Jossey-Bass.

Mezirow, J. (1991). Transformative dimensions of adult learning. San Francisco: Jossey-Bass.

Rossman, M. & Rossman, M. (Eds). Applying adult development strategies. (New Directions for Adult and Continuing Education): No. 45, Spring 1990. San Francisco: Jossey-Bass.

Sheehy, G. (1985). Passages: Predicable crises of adult life. New York: Bantam Books.

Zemke, R. & Zemke, S. 1995, June). Adult learning, What do we know for sure? Training, 32, 31-40.

AUTHOR'S BIOGRAPHY

Merrill R. Karp is an Associate Professor in the Department of Aeronautical Management Technology at Arizona State University. He received his Ph.D. in Administration & Management from Walden University in 1996, with a specialization in Aviation Education & Training. He attained an MA in Business Management and Supervision from Central Michigan University in 1975 and a BS in Aeronautical Technology from Arizona State University in 1967. He also attended the United States National War College in Washington D.C. in 1985. Dr. Karp is a retired United States Air Force officer. His research and publication agenda focuses on: aviation human factors, cockpit/crew resource management, cooperative and collaborative learning, and adult learning in aviation education.

Appendix A

PERSONAL CHARACTERISTICS

Directions: Circle the phrases that you think best reflect your personal characteristics. Circle as many phrases as you feel are applicable.

Observe rather than talks or acts

Organized in approach to tasks

Like to read

Usually a good speller

Memorize by seeing pictures or graphics

Not easily distracted

Find verbal instruction difficult

Have good handwriting

Remember faces

Use advanced planning

Doodle

Quiet by nature

Meticulous, neat in appearance

Notice details

Talk to myself aloud

Enjoy talking to others

Easily distracted

Have more difficulty with written directions

Like to be read to

Memorize steps in a sequence

Enjoy music

Whisper to myself while reading

Remember names

Easily distracted by noises

Hum or sing

Outgoing by nature

Enjoy listening activities

Enjoy programs where a speaker tells stories

In motion most of the time

Like to touch people when talking to them

Like to handle objects

Tap pencil/foot while studying

Enjoy doing activities

Reading is not a priority

Usually a poor speller

Solve problems by physically working through them

Will try new things

Use hands when talking

Express emotions thorough physical means

Dress for comfort

Outgoing by nature

Like working with hands

Adapted by Dr. Merrill R. Karp, Arizona State University, from instrument by Jan R. Amstutz, Director, Intensive English Language Center, California State University, as presented to "Aviation Communication: A Multi-Cultural Forum Symposium," April 11, 1997, Embry-Riddle Aeronautical University, Prescott, AZ.

Appendix B

Suggested Aids for Learning Styles

Directions: Add each individual column of the "Personal Characteristics" assessment instrument. The first column indicates characteristics of "visual learners," the second column indicates characteristics of "auditory learners," and the third column reflects characteristics of "hands-on, tactile, or kinesthetic learners." The column with the highest number of annotated occurrences reflects the most dominant learning style; the column with the second most occurrences reflects the second most dominant learning style, etc. There is a possibility that two or even three of the columns are the same. If so, then those styles are equally dominant. The following aids may be helpful to enhance your particular dominant learning style, or to strengthen a weaker one. Some of the suggestions are the same for more than one learning style, but for different learning and processing reasons.

<u>Visual</u>

Read

Form pictures in your mind

Take notes in class

Use notebooks to summarize notes after class

Draw/use drawings

Use charts/graphs/maps

Watch lips move in front of mirror while speaking

Use study cards

Use photographs and pictures

Watch TV

Watch videos

Use color codes

Use acronyms, visual chains, and mind maps

<u>Auditory</u>

Use video and audio tapes

Watch TV

Speak/listen to speakers

Make up rhymes/poems

Read aloud

Talk to self

Repeat things orally

Use rhythmic sounds

Have discussions with classmates

Listen carefully

Use oral directions

Sound out words

Say words in syllables

Use word links, like rhymes, poems, and lyrics

<u>Hands-on/Kinesthetic</u>

Physically "do" the task

Practice by repeated motion

Pace/walk as you study

Take a lot of notes in class

Write down thoughts during day-to-day activities

Write on surface with finger if paper is not available

Write lists repeatedly

Role-play

Think or practice while exercising

Associate feelings with concept/information

Stretch/move in chair

Watch lips move in front of mirror while going over lessons

Adapted by Dr. Merrill R. Karp, Arizona State University, from instrument by Jan R. Amstutz, Director, Intensive English Language Center, Califomia State University, as presented to "Aviation Communication: A Multi-Cultural Forum Symposium," April 11, 1997, Embry-Riddle Aeronautical University, Prescott, AZ.