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ABSTRACT

Amateur radio is a technology and activity that offers great potential when integrated into academic or vocational curricula. Programs with electrical, electronics, and electromechanical content can benefit from the use of amateur radio, and can also enhance language and communications skills. The biggest value of amateur radio may lie in its ability to enhance a student's motivation and self-esteem. In addition to its specific vocational and technical applications, amateur radio can assist in teaching basic skills and in reducing the isolation of students and teachers as it promotes interdisciplinary education and cultural awareness. Amateur radio is distinctly different from citizens band, as it is a noncommercial service. Ham operators do not need an electronics background, although technical knowledge and skills are helpful. Several examples of the educational use of amateur radio illustrate its potential for academic and vocational education. (Contains 23 references.) (SLD)

A Proposal For Using

– AMATEUR RADIO IN THE CLASSROOM –

December 1994

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TEACHING WITH TECHNOLOGY:

A Proposal For Using

– AMATEUR RADIO IN THE CLASSROOM –

Forward:

Despite the recent focus on the use of technology in education, there is a dearth of information about amateur radio in the mainstream educational literature. Yet, amateur radio is a technology and an activity that offers great potential when integrated into academic or vocational curriculum. Amateur radio ***applies mathematical and scientific principles*** and ***uses technology*** to ***communicate with people***. It is thus both a ***technical*** and a ***social*** activity which can enhance learning in almost any subject area at any grade level.

There is perhaps no better way to suggest where the exposure of a youngster to amateur radio might lead than to refer to the forward of *Now You're Talking*, the American Radio Relay League's text written for those studying to obtain their first license. That forward page is reprinted here in its entirety, with permission of the American Radio Relay League. (Underlining has been added for emphasis.)

Foreword

Amateur Radio is a very exciting avocation to many people all over the world. It provides a medium through which people in all walks of life can share a common interest. Amateur Radio also has many faces and can be seen differently by each person. To some just the ability to talk to people of diverse cultures is what drew them to Amateur Radio. For some it provides an important communications link home from remote parts of the earth (and beyond). The Amateur Radio Service enjoys access to the radio waves with very few restrictions. This has given many electronics experimenters an opportunity to dabble at the forefront of communications technology that they would not otherwise have.

I call it an avocation because to many of us it is much more than just a hobby. My own entry into Amateur Radio was in 1963 at the age of 12. Little did I know that it would play such an important role in my future life. During my college career I was employed by the university planetarium as a technician. The hands-on experience with soldering iron and voltmeter that I acquired in my Amateur Radio activities got me that job. Later when applying for a job teaching physics at a technical college, I was turned down until they found out I was a "ham." The ability to teach practical electronics learned through Amateur Radio, as well as physics, gave me the edge over the other candidates. The practical technical experience I have gained through Amateur Radio has continued to serve me well throughout my professional career.

The climax of my Amateur Radio activities (so far) has been the operation of SAREX-2 from aboard the space shuttle *Columbia*. Between December 2 and December 10, 1990 I was able to communicate with over 100 people on voice, and nearly 1000 on packet radio! Imagine the excitement of talking to Amateur Radio operators all over the world from earth orbit. It was indeed the ultimate DXpedition!

The Federal Communications Commission and the ARRL have now provided even more ways than ever before to enter this continually changing "hobby." With the new laws in place you can choose an entry-level license that best suits your current level of expertise. Depending upon your interests, you can also choose a license that either stresses the technical or traditional aspects of Amateur Radio. Whatever direction you decide to take you will enter a worldwide fraternity that will never cease to provide new challenges. Best of luck, and see you on the air!

73,

Ronald A. Parise, WA4SIR

Amateur Radio and Vocational–Technical Education:

One might easily see how amateur radio is a useful technology for inclusion as part of a vocational electronics program, but what about elsewhere?

Prior to specialized instruction in a vocational program, students must have basic academic knowledge and skills. How is it possible to learn accounting for example, if the student does not have basic math skills? And, especially in business, students must be able to effectively communicate with other people. They need to understand and appreciate the world around them, and the telecommunications technology they will use in the business world, in order to make wise business decisions. Amateur radio can teach all these things.

Vocational educators are now involved in Tech Prep. Tech Prep stresses applied academics. Creative applications must be found to teach math, science and other subjects. As will be discussed in this paper, amateur radio can be used to enhance learning in almost any subject area.

In any vocational program, it is desirable for students to first have a good academic foundation. Lack of this foundation limits the effectiveness of the vocational program. Thus, anything that can help teach academic and social skills is useful to vocational education. Vocational educators, by virtue of their technical skills and interest in applied academics, are the most suited individuals to facilitate the use of amateur radio in the academic as well as vocational classroom.

We will return to the subject of amateur radio and academic education later. It is an area where vocational–technical education has an opportunity to contribute to academic programs as well as to promote itself.

Knowledge of electrical principles is required in many programs:

Beyond contributing to the teaching of academic foundations, amateur radio is a technology that has application in any vocational program that requires knowledge of electricity and electronics. The TOP (Teaching of Occupational Proficiencies) database

complied by NY State Board of Cooperative Educational Services (BOCES) educators contains curriculum content in terms of subject modules, topics and competencies, in 10 occupational areas. At least 8 out of the 10 areas list modules in electricity/electronics.

Business occupations are not in the TOP database, but here again, it is impossible to ignore electronics. Business today depends on computers, fax machines and other telecommunications devices. The office environment is becoming more electronic all the time. Thus, a student who understands or at least is comfortable with electronics will have an advantage in the business world.

Electrical/Electronics Technology Programs:

It is clear that programs with electrical, electronics, and electromechanical content can benefit from the use of amateur radio in the curriculum. Trade Electronics, Electronics Technology, Automotive Technology, and HVAC are a few of the most obvious examples. But all the ways that a program might benefit may not be so obvious at first. It is clear, however, that a background in math and science is desirable and even necessary for a student to get the most out of a technical program. As noted, amateur radio can help teach these subjects in the academic classroom. If students entering a vocational program have a better academic background, more time could be spent on the vocational course content and less in remediation. In fact, if students are introduced to the technology in academic courses earlier in their education, they may develop or maintain an interest in technology which may lead them to choose a vocational or technical program in the first place. So, the use of amateur radio as a teaching tool in the academic classroom may encourage students not only to study math, science and other academic subjects, but may also serve to promote vocational and technical programs.

In electronics technology, one might think that the biggest problem of students entering the program would be inadequate math or science background to handle the math and science–related theory. This is certainly a concern. Amateur radio can help teach those subjects, even prior to entering the vocational program. But the biggest problem seen by the instructor of the vocational Computer Electronics program offered by OCM BOCES in

Syracuse is the students' ***lack of adequate language and communication skills*** (R. Braun, personal communication, October 1993). Amateur radio is ideally suited to help teach these skills. Amateur radio activity can be divided into two categories. Not only is it a technical activity, it also involves ***communicating*** with other ***people***. Thus, the student who may not otherwise have occasion or desire to communicate may be encouraged to develop language and other social skills through involvement with amateur radio.

Radio and Computers:

One might think with today's trend towards digital technology that the market for technicians with radio–related skills would be limited. Computers are everywhere, and the demand for people that can operate, maintain and repair them will continue to grow. But those who also understand analog circuits, and radio theory in particular, will have an advantage. As processing speeds increase, the signals running around inside a computer and on the interconnecting cables are pushing higher into the radio frequencies. The newest development is to actually replace the hard–wired connections, such as between computer and printer, or between networked computers in an office, with wireless interfaces. Hoover (1993), in an editorial in the trade publication *Applied Microwaves & Wireless*, writes: "So it is with confidence I predict that the tangle of cables interconnecting my computer, monitor, keyboard, mouse, modem and printer will soon disappear, to be replaced by simple wireless ***transmitters and receivers***" (emphasis added). Thus, while on the surface it may appear that the computer revolution will decrease the role of traditional electronics, this is not necessarily true. As interconnection of computers and information sharing increase, the demand for those who understand communications technology will also increase.

Value of Obtaining an Amateur Radio License:

While the primary intent of including amateur radio in an electronics program (or any other program, for that matter) is not necessarily to have students become licensed, obtaining a license is a worthwhile goal. The comments of astronaut Ron Parise already cited are a testimonial to the value of an amateur radio license for those seeking employment in a

technical or scientific field. While not a commercial license, it is an indication of interest and ability. It is issued by the Federal Communications Commission, and as such is nationally recognized.

There is a direct connection between the amateur and commercial licenses, however. The examination for the commercial General Radiotelephone Operator License, required of all technicians who repair and adjust marine and aviation radios, presently contains questions which are taken directly from the pool of questions used for amateur exams. West (1994) notes in a recent article in *73 Amateur Radio Today* that the amateur radio Advanced and Extra Class license study guides adequately explain how to solve for two–thirds of the commercial Element 3 questions. A student who has studied the Advanced and Extra Class question pools, already knows at least two–thirds of what could be asked on the commercial test.

Amateur radio's biggest value, however, might be in its enhancement of the student's motivation and self–esteem. A student who earns an FCC license has achieved something few of his or her peers have done, and has received recognition of his or her achievement from outside the school– from the federal government in fact! This is not just paper recognition. An amateur radio license grants special privileges and allows the student to join the worldwide ham community.

In the school, students who obtained licenses would likely feel special. They would be able to act as control operators to allow other students ***and teachers*** to experience amateur radio. A school radio club is a ready–made vocational organization. Teachers who have licenses would be more than just advisors, they would be accepted as part of the club– part of the same amateur radio fraternity as the students– by virtue of their common interest and experience with the students. The artificial barrier of age or status drops away, and the students will more readily learn from fellow amateurs.

Amateur Radio's Dual Nature:

Most people think of amateur radio as a technical activity. But at the same time, it is a social activity that involves oral and written communication between people. As a result of this dual nature, it has the potential to address many problems in education.

For example, the isolation that tends to exist in schools can be reduced through the inclusion of amateur radio in the curriculum. This isolation takes many forms, including: isolation from the outside world; isolation of teachers; isolation between subjects; and isolation of academics from applications.

Recent reports such as those by the Secretary's Commission on Achieving Necessary Skills have cited the need for a better foundation in basic skills (SCANS, 1991). As an activity involving communication, amateur radio can serve as a vehicle to teach the most basic skills required for learning – listening and speaking. Communication is inherently between individuals or groups, and thus many interpersonal or 'soft' skills can be practiced. And amateur radio can certainly provide concrete examples or hands–on applications in most academic subjects.

The American Radio Relay League (ARRL) provides much free and low–cost material for school teachers. They may be contacted at the following address:

American Radio Relay League
Educational Activities Department
225 Main Street
Newington, CT 06111

The following chart was compiled by the ARRL Educational Activities Department and is reprinted with their permission. It suggests some of the possible uses of amateur radio in school curriculum.

AMATEUR RADIO--USES IN SCHOOL CURRICULUM

SUBJECT AREA	Elementary Level	Jr High/Intermediate Level	High School	College
Communication arts, Language arts	• Verbal skills • Reading/Writing/Spelling	• Conversational skills • Record keeping • Reading/Writing/Spelling • Note-taking skills • Letter writing	• Higher verbal skills • Reference material skills • Following directions • Reading/Writing/Spelling • Note-taking skills • Letter writing • Communication careers	• Careers in communications
Mathematics: Algebra Geometry Business math Scientific notation	• Formulas • Metric System • Computing distances • Measuring • Using calculators	• Metric System • Charts and graphs • Electrical formulas • Estimating • Ratios • Using calculators	• Algebraic equations • Calculating electrical values • Calculating physics problems • Metric System • Using calculators	• Calculating electrical values • Calculating physics problems
Social studies, World studies, Government	• Maps/globes • Learning new cultures • Meeting people from other lands • Current events	• Longitude/latitude • World time zones • International date line • Meeting people from other lands • History of radio • Cartography • Current events	• International communications law • Federal Communications Commission • Meeting people from other lands • History of radio • Cartography • Current events	• International communications law • Federal Communications Commission • History of science and technology • Current events
Computer science	• Collecting data • Comparing data • Making tables • Packet (computer) radio	• Interpreting data results • Compiling data • Comparing data • Making charts • Packet (computer) radio	• Estimating data results • Compiling data • Comparing data • Making graphs • Packet (computer) radio	• Satellite tracking • Decoding telemetry • Packet (computer) radio and networking • Store and forward satellite BBSs • Using X.25 protocol
Science Physics	• Radio waves • Magnets • Meteorology • Basic electricity • Science careers	• Radio waves • Ionosphere/Troposphere • Ohm's Law • Basic electricity • Radio frequencies • Meteorology • Space science • Scientific Method • Science careers	• Satellites • TV transmission • Electronic theory • Electromagnetic waves • Space science • Meteorology • Scientific Method • Science careers	• Satellites • TV transmission • Electrical Engineering • Space sciences • Meteorology • Radio propagation • Communications for Solar Car races
Electronics technology	• Basic electrical components • Basic electrical formulas	• Basic electronics • Basic circuits • Wiring projects • Soldering • Electrical safety	• Advanced electronics • Advanced circuits • Electronic construction • Soldering • Electrical safety • Reading schematics • Antenna propagation • Careers in technology and electronics • System architecture	• Circuit design and construction • Reading schematics • System architecture • Satellite communications
Foreign languages	• Foreign customs	• Learning foreign words • Studying English roots	• Speaking foreign languages • Listening to short wave foreign broadcasts • Letter writing in foreign languages	• Speaking foreign languages • Listening to short wave foreign broadcasts
Graphic arts		• Design	• Design • Graphic reproduction	• Design
Industrial arts			• Fabricating metalwork • Circuit board layout • Schematic capture (CAD) • Field construction (antennas) • Component acquisition	• Circuit board layout • Industrial Engineering - fabricating metalwork - satellite construction

Amateur radio is a readily available technology that has many applications in both the academic and vocational classroom. It can be used at virtually all grade levels in all subjects. It can enhance learning in the cognitive, affective and psychomotor domains. By virtue of it's dual nature, it can help create and maintain an interest in math, science and technology for students who are socially oriented, and in social subjects and skills for those who are technically oriented.

Electrical and electronic devices have become a part of every day life for almost everyone in today's world. A knowledge of basic electrical principles would be beneficial to all. Yet many students are not interested in or comfortable with the subject. Amateur radio offers a means of bringing theory down to a concrete, hands–on level by offering an activity which is participatory and has both social and technical components.

Amateur radio need not be overly complicated or expensive. The cost of a reasonably well equipped amateur radio station is comparable to that of one multi–media computer and peripherals. At least one licensed individual with some technical skill is needed, but each individual teacher and student does not need a license to actively participate.

Technically competent vocational educators could serve as the facilitators in an amateur radio program. By using amateur radio in their classrooms and offering it as a resource to others, vocational educators knowledgeable in electronics have an opportunity to provide applications, promote vocational education, enhance their own programs as well as curriculum in other academic or vocational areas, and tie together teaching of vocational, academic and social skills.

Amateur Radio, Academics, and the School Environment:

Applications of amateur radio in vocational–technical programs have been discussed. Some specific applications to academic curriculum have been suggested by the ARRL chart. However, amateur radio has the potential to address many general problems experienced in the school environment. This may be its highest potential.

Motivating Students:

One of the most basic problems any teacher faces is motivating students to learn.

Schoolwork faces stiff competition from every corner. One of the biggest competitors is electronic entertainment media such as radio and television. Students can relate to radio, and therefore may be interested in actually being able to talk on the radio. Amateur radio is a fairly unique activity that most students would probably not be able to participate in outside of school.

Students need to see how what they are asked to learn is important to them. A curriculum which includes amateur radio can demonstrate the importance of good language skills, the application of math and scientific principles, and the reality of other languages, peoples and cultures.

Russell Hulse (ex–WB2LAV) and Joseph Taylor (K1JT), winners of the 1993 Nobel Prize in physics, both cite amateur radio as playing a part in their love of science. Hulse said "Ham radio became motivation for me to continue my science career" (Douglas, 1993).

Teaching Basic Skills:

Numerous studies and reports have indicated the need for a better academic foundation in basic skills. The SCANS report (1991) *What Work Requires From Schools* includes the basic skills of reading, writing, arithmetic, ***listening and speaking*** in its Three Part Foundation . Since amateur radio involves interpersonal spoken and written communication as well as technical activity, all these basic skills can be addressed.

Isolation In The School:

Isolation has an adverse effect on learning. Students need to see that subjects have relevance to each other, to the world in general, and to their lives in particular. Teachers need to have ways of demonstrating that relevance. Teachers also tend to become isolated themselves, as they concentrate on school activities. Amateur radio by its very nature as a communications activity tends to reduce isolation.

– Isolation of Teachers:

Teachers work in classrooms that are isolated. Their intense and busy schedules can cause them to be isolated from their colleagues for most of the workday. Stevenson (1992) noted that teachers in Beijing were incredulous upon hearing a description of a typical day in American schools. A typical American teacher spends most of his or her time at school isolated in the classrooms, with few opportunities for interaction or consultation with other faculty.

Teachers' busy schedules also tends to isolate them from the outside world. Between efforts to communicate with each other, advance their academic qualifications, keep up with the educational community and communicate with parents, in addition to actual lesson planning, teaching, grading, and so on, there may be little time left over for interaction with the business, engineering and scientific communities.

Involvement in an amateur radio program can help keep academic teachers in touch with technology. This is even more important for vocational teachers of technical subjects. Assuming the teacher is active in amateur radio both in and out of class, it will provide a great opportunity to keep up with technical developments in electronics, as well as other areas. There is a high degree of technical skill, interest and activity in the amateur community.

– Isolation of Subjects:

A recent grant proposal written by the Clary MSM Middle School in Syracuse states "The relationship between teacher and student in secondary schools is limited by the subject–area specialties of teachers. English teachers see English students, math teachers see math students, and so on..." It takes a special effort to see the whole student (and to encourage the student to see the 'big picture' – the interrelation of all subjects). "In recent years, the student–teacher relationship has been narrowed as a result of the influence of standardized tests. We have been successful in raising test scores. ***We have, however, traded off the attention that we might have paid to the application of skills and the solution of practical problems*** (emphasis added). Since there are no standardized tests for working in

groups, we have also paid little more than lip service to the social aspects of working and learning in groups" (Clary, 1993).

This proposal was for funding to purchase and network additional computers within the school. The objectives were to enhance basic academic skills and thinking skills through the use of technology. The SCANS list of basic and thinking skills was specifically mentioned. By developing a more holistic curriculum in which several subjects were tied together through the use of computer technology, the isolation between subjects, between teachers, between students, and between students and teachers would be reduced. The same thing could be achieved on a wide scale in an innovative way with an integrated amateur radio curriculum.

– Isolation from Cultural Diversity:

No doubt networked computers in a school can help to integrate curriculum. Each school, however, has its own culture, formed by physical location and environment, school administration and staff, students and community. One does not need to communicate or travel very far to find a different culture on some scale. The language, experiences and viewpoints of students in an inner–city school and rural school only 30 miles apart can be quite different. Indeed, there can be significant differences between schools in the same district or grades in the same school. But on a larger scale, the U.S. is more of a homogeneous culture. Unlike many other areas of the world, we are isolated from other countries, languages and cultures.

Students need to experience these diversities, both local and international, to appreciate them. This experience can demonstrate the need for good language and communication skills and motivate an interest in social studies and foreign language. Travel to foreign countries, or even to other schools or communities is generally not practical or economically possible. Amateur radio can provide a means of ***direct, personal, interactive contact*** with other cultures on the local, national and international level. It can add the dimension of spoken communication, which is lacking in computer telecommunications.

– Isolation from Technology:

Not withstanding the need for good academic, interpersonal and communication skills, there is a growing need for better technology education. Although we all use and benefit from modern technology, most people have little understanding of it. Unless specific steps are taken to ensure otherwise, most teachers, and therefore students, tend to be isolated from technology.

A 5th grade teacher who has had great success using shortwave and amateur radio in his classroom, has observed: "Try to find a teacher who wants to use technology, let alone enjoys using it... "In the almost three years I've been experimenting with radios in my classroom, there hasn't been one teacher who came in to see what I do with them... "Some other teachers who've been around a lot longer than I have told me to be happy I'm ALLOWED to HAVE radios in my classroom, and not to complain about the lack of enthusiasm on the part of others" (A. Ninno, personal communication, February 21, 1994).

Perhaps this is because the teachers themselves are not comfortable with technology. And if this is the case, how can we expect the students to be?

Technology in Education:

The superintendent of a large suburban school in the Syracuse area recently observed that "slowly but surely, a lot of people are coming to the conclusion that technology is the key to the restructuring of American education," and proceeded to list four ways a computer can be used: as a referral tool to call up images and text, as an organizer, as a communicator, and as a general thinking machine (Melvin, 1993).

While it is true that computer skills are increasingly essential in today's world, many other technologies besides computers exist, and have potential to enhance learning. Although video and telephones were mentioned in Melvin's discussion, clearly the focus was on computers, particularly as tools to ***access information and communicate***. And this is typical of the way technology is thought of in education. The word "Technology", when used by most educators, seems to be synonymous with "Computers".

At the 28th annual New York State Association for Computers and Technologies in Education (NYSCATE) conference in November 1993, computers were the focal point. Interactive games and simulations, and CD–ROM based graphics programs abounded, but using computers for information access and telecommunication via Internet and other electronic networks may have been the most common topic.

Educators are recognizing that we are living in an information age. Schools must become part of this communications revolution. However, most classrooms don't even have telephones, and to get on the "information superhighway", a phone line is almost essential.

However, there is another way to communicate electronically which is familiar to all. Radio has been for many years the main way that information is transmitted. Radio is familiar to everyone in the form of commercial broadcast stations. Television, cellular phones, and the ubiquitous beeper are forms of radio. Most telephone voice and data communications travel long–distance via microwave radio links. Amateur ***radio*** can be a very effective technology for education.

How can Amateur Radio be Used in the Classroom?

While at first glance it might be considered something suited only for the science or electronics technology classroom, amateur radio can also enhance teaching of communication skills, social studies and foreign language.

Radio can teach the most basic of communication skills: listening and speaking. Simply listening to foreign shortwave broadcast stations can expand horizons, but ***two–way*** communication via amateur radio will facilitate ***interaction between individuals*** on a personal basis. It can bring people, places, and events from around the world into the classroom in an interactive manner, expanding students' horizons and generating interest and enthusiasm. While it can't match the information access capabilities of Internet or similar hard–wired networks, an amateur radio mode known as packet radio provides access to a world–wide system of bulletin boards and electronic mail. By using a computer or

terminal, a low–cost radio and a modem, an individual can tap into this network, without any user fees and without the need for a telephone line.

Amateur radio can even give students a chance to communicate with astronauts in the space shuttle, through NASA's SAREX program. Cosmonauts in the Russian space station MIR are also regularly active on the amateur radio frequencies, and many OSCARs (Orbiting Satellites Ca. ying Amateur Radio) are available to explore the world of satellite communications.

Thus, especially when used as part of a holistic curriculum, amateur radio has the ability to integrate subjects and motivate students. It can generate interest in math, science, and technology for students who might otherwise avoid these subjects and concentrate on liberal arts. It can at the same time demonstrate the importance of good language and communication skills to students who might otherwise feel that these "soft skills" have no relevance to their interests in science or technology.

What about Cost?

All this might sound complicated and expensive. A key point in Melvin's (1993) discussion was that "technology and computers are expensive items– particularly during difficult economic times." But a learning center where students can eavesdrop on the world using shortwave radio can be set up for less than the price of the most basic computer, and requires no license or special training to operate. A more complete, interactive learning center – an amateur radio station – where students can talk with the world, takes a little more effort, but can still be had for about the cost of one multimedia computer.

Just What is Amateur Radio?

The amateur radio service is ***distinctly different from the citizens band*** (CB). The Federal Communications Communication (FCC) provides the following definition in the regulations governing amateur radio (known as Part 97): "A radio communication service for the purpose of self–training, intercommunication, and technical investigation carried out

by amateurs, that is, duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interest." Thus the word "amateur" in this case does not imply inexperience, or lack of skill, but simply that the amateur radio service, unlike the broadcast and business radio services, is noncommercial in nature (Palm, 1993).

The Basis and Purpose of Amateur Radio is summed up by five basic principles stated in Part 97:

1) "Recognition and enhancement of the value of the amateur service to the public as a voluntary noncommercial communication service particularly with respect to providing emergency communications."

2) "Continuation and extension of the amateur's proven ability to contribute to the advancement of the radio art."

3) "Encouragement and improvement of the Amateur Radio Service through rules which provide for ***advancing skills in both the communication and technical phases*** of the art."

4) "Extension of the existing reservoir within the Amateur Radio Service of ***trained operators, technicians and electronics experts***."

5) "Continuation and extension of the amateur's unique ability to enhance international goodwill."

Perusing the FCC definition and basic principles, we can see that the focus of amateur radio is on public service, technical advancement and training, and communication skills. All of these are consistent with the goals of education.

Amateur radio is different than almost any other radio service in that it allows and even encourages experimentation. Hams, as amateur radio operators are also called, come from all walks of life, bringing their interests, knowledge, and experience.

What Can You Do with Amateur Radio?

Referring to the FCC's basic principle number 5, Palm (1993) comments that "hams are unique– they can travel to the far reaches of the earth and talk with amateurs in foreign countries simply by stepping into their radio 'shacks.' H.G. Wells had his time machine–

hams have space machines!" Hams can even travel into space– and talk with NASA space shuttle and MIR space station crews!

Through appropriate choice of equipment and operating parameters, one can communicate across town, across the country, or around the world. Factors such as the time of day, time of year, level of sunspot activity, atmospheric conditions, and the type of equipment available determine the effective communication range, especially in the "HF" or long distance bands. And of course, there has to be a station listening 'at the other end' to hear your call. Unlike the telephone, there is not a guarantee of communication to a specific place at a specific time. But when all the activities involved in setting up and operating a station are combined with actual on–the–air time, in an integrated learning environment, there is great potential to enhance curriculum.

But don't you have to Know Morse Code?

Electronic communication can take many forms. The earliest and simplest was Morse code. It is still used today. It's value is that it can be sent and received with very simple equipment. It uses very little bandwidth, meaning that many stations can operate very close together in frequency. Educationally, it has value in teaching listening and concentration. Carole Perry, who teaches amateur radio as part of the regular curriculum at PS#72 in Staten Island, notes that special education teachers find it especially effective for this purpose. She also mentions that ESL (English as a Second Language) teachers see it as effective for students who don't speak English and are shy about talking to other children. Social studies teachers use it as an introduction to the history of the telegraph in the Old West. As with all facets of amateur radio, there are many curriculum–related possibilities (Perry, 1992).

Many young students are attracted to the idea of learning a 'secret code' that most adults don't know, so it can be a way to get them interested. But it is not necessary to know Morse code to participate in amateur radio.

Voice Communication:

Voice communication is probably the most prevalent operating mode on the amateur frequencies. Local communication is usually done using VHF–FM, which is usually very clear and reliable. A small hand–held radio can sometimes be used in conjunction with a repeater to extend range. Repeaters are automatic stations in strategic locations which receive and automatically retransmit signals. They are usually built and maintained by local radio clubs. Long–distance voice communications are usually via HF–SSB. The quality of these signals depends on many factors, as previously noted, but they are usually of sufficient quality to be used in a classroom.

From exploring the community to exploring the world, voice communication has many possibilities. ESL students can converse in their native language and translate for the rest of the class. The student thus goes from feeling different or left out to being the star of the class. Foreign language students can practice with native speakers using real dialogue. Social studies students can explore the world. Introduction to occupations can be a continuing process, as students talk with other hams about their jobs.

Video:

There are several forms of amateur television. Amateurs can also receive weather maps from satellites, and there are other forms of image communications.

Digital Communication:

Several modes of amateur radio digital communications are possible. One of the oldest is radioteletype. This is still used both commercially and by amateurs. With the advent of computer technology, advanced modes have been developed by amateurs. These employ various 'handshaking' or error–correcting schemes which improve the quality of transmission. The most popular and accessible mode is known as Packet Radio. This enables individual stations to access packet bulletin boards and automatic switching/ relay stations called nodes. Stations can connect via radio directly or through nodes to each other for live

keyboard–to–keyboard conversations. Packet is the radio equivalent of connecting to bulletin boards using your computer, modem and telephone. The modem is replaced by a device called a TNC, which is the interface between the computer and radio. The radio replaces the telephone link. Packet Radio allows hams to send and receive messages to and from each other around the world. It is much slower than services such as Internet, but it is also free.

But don't you Need a License?

Amateur radio is not CB. It is much more versatile and sophisticated. Every amateur radio station and control operator must have a license issued by the Federal Communications Commission. There are several classes of licenses, each requiring different levels of knowledge and granting different privileges. The entry–level licenses are not difficult to obtain. Students at elementary and middle school level have obtained amateur radio licenses. However, it is not necessary to have students obtain licenses to use amateur radio as a teaching tool (although that does have value in itself).

As long as there is a licensed control operator present to ensure certain operating requirements such as frequency and power limits are being met, anyone can communicate using amateur radio. Thus, with one licensed operator, the whole class can participate. The licensed operator could be a ***student***.

Don't you have to be an Electrical Engineer to Understand it all...?

The more technical knowledge one has, the more potential there is to get the most out of amateur radio. However, it is not necessary to have an electronics background to be a ham. In fact, a large percentage of current licensees are <u>not</u> engineers or technicians. However, it is helpful to have someone with technical knowledge and skills.

There is a multitude of instructional material for the non–technical person. And often, exposure to amateur radio motivates a person to acquire or upgrade technical skills, either as an avocation or to pursue a technical vocation.

A technically knowledgeable vocational educator could provide a valuable service, and promote his or her vocational program at the same time. He or she could provide expertise to implement amateur radio in their own classroom, and provide it also as a resource to be used by other teachers in academic and/or vocational subjects. In a large school or a school district, this could become a full–time job if amateur radio was fully integrated into the curriculum.

Examples:

Most articles in educational literature relating to radio in the classroom discuss shortwave listening, as it seems more accessible to the average teacher. It is most often mentioned in connection with teaching of social studies or foreign language. Amateur radio provides all the benefits of shortwave listening, and more.

Shortwave broadcasts provide a window to the world, allowing students to hear news, views and entertainment. Mustoe (1988) concludes that "many students have no interest in reading about a place about which they know nothing. Many teachers have encountered students that seem not really to believe, or care, that other cultures and places exist. Interaction with these places can sometimes motivate an interest and appreciation for them."

But is listening really interaction? With amateur radio, students will actually have a chance to talk with people in these places. They become a part of the world and its' events. Wood (1977) points out that "amateur radio capitalizes on a unique feature that educators advocate–***student involvement*** in live communications." Consider the frequent mention of ham radio in connection with news reports on the war in Bosnia, for example.

There are many successful educational programs in existence which include amateur radio. However, to find them, one generally has to turn to the amateur community itself. The Amateur Radio Relay League, various amateur radio periodicals, and last but certainly not least, actual on–the–air contacts, all provide examples and ideas.

– Staten Island, NY: Carole Perry

A successful program exists in Intermediate School 72 in Staten Island. Carole Perry [WB2MGP] works with other teachers to integrate all subjects into her ham radio classes for grades 6–8. Principal Stanley Katzman says "Carole Perry has proved, day in and day out for over 9 years, that this multi–media faceted approach to a fascinating subject can produce interested, excited, happy learners from every segment of our student body. I've seen youngsters who have been 'written off' by other subject teachers, blossom and become 'stars' in Carole Perry's Ham Radio Class." In her monthly column in *73 Amateur Radio Today*, Ms. Perry provides a multitude of examples of how amateur radio can support teaching of nearly any subject .

Among other things, her students have talked with the Pentagon (1992, October), with students in a remote Manitoba village (1991, November) , and with Rich Wilson [WA1BZE], a ham on board the Great American II, a 53 foot sailboat attempting to break the long–standing record time for sailing between San Francisco and Boston. Conversations with Rich led to lessons about such diverse topics as boats, navigation, weather, teamwork, geography and communications. Students heard about albatrosses, flying fish dolphins and whales, sand from the Sahara desert over 2000 miles away found on the sails, rainbows off the coast of Brazil, and the teamwork needed to be part of a two–man crew on a long voyage. Students followed the entire adventure, plotting the team's progress on a map. As a result of their involvement, several students were invited to meet Rick Wilson in person (1993, June & September). No pictures, audio or videotape presented after the fact could have motivated the students as much as the ***live, real–time involvement*** made possible by amateur radio.

– Syracuse, NY: The 'School Net'

Closer to home, the author and two teachers have been involved in an activity that brings together students in Utica, Syracuse and Central Square. The schools are separated by 30–60 miles, and classes communicate by VHF radio through a local repeater. Though VHF only affords short distance communication, the students are still in some ways communicating with other cultures. The Clary MSM Middle School is a inner–city, mostly

minority school in the City of Syracuse. The General Herkimer Magnet School is a school in the smaller city of Utica, and the Central Square Middle School is a rural school 30 miles outside of Syracuse. As a volunteer learning facilitator, the author [KC2WI] provides the means to get 7th graders at Clary on the air. At Central Square, Jim Kuhl [N2STK] involves his 6th grade science class and at General Herkimer, Anton Ninno [N2RUD] makes extensive use of both shortwave and amateur radio in his 5th grade class.

Students start off the year learning about radio, especially how to communicate in a clear and understandable manner. They get to know students in the other classes by introducing themselves on the air. As they get comfortable with the radio, they start exchanging more information. The teachers then steer the conversation to academic topics by having their students make up questions for the other classes to solve. Thus, the students are learning communications skills, encountering technology in an interactive manner, discovering more about differences and commonalities between each other, and discussing school–related topics.

Other stations check into the net. Occasionally another school will be able to participate if they find a volunteer ham to help them out, but mostly the students talk to individual hams. Everyone who checks in is asked to talk about, among other things, what they do for a living. The students ask a lot of questions. It is like having multiple guest speakers in the class. Thus, students are being ***exposed to the world beyond schoo***l, including being ***introduced to real–world occupations***.

The *Syracuse Herald American* featured an article on the school net and other local school–related amateur radio activities. The article notes that "the teachers involved say amateur radio can be a handy tool for helping students grasp nearly every subject from physics to math to language arts, and boost their confidence and communication skills". Mr. Ninno observes "it's the perfect way to integrate your classroom, which is one of the buzzwords today. At first, kids [are] talking to each other asking questions like 'Do you have

a class pet...' "Then they'll start trading social studies and science questions... ***and the kids all start digging through their books***. Usually we have a hard time getting them to do that" (Grazma, 1993).

What is the benefit of this type of activity to vocational education? Not only does it help improve academic and social skills and provide exposure to real-world occupations, it introduces students to science and technology at a level they can see, touch and hear. It therefore ***introduces them to vocational concepts prior to high school***. It contributes to a program of vocational awareness and education from kindergarten on, as recommended by the Career Pathways task force and others. It can be part of the awareness and orientation phases specified in Greenan's (1993) K–Adult Vocational Education Program Model.

– Transmit and Ye Shall Receive...

In order to find out more about how other schools were using amateur radio, a general request for information was sent out via the packet radio network, a system of computer bulletin boards interconnected by amateur radio. Responses were received from as far away as Alaska.

Mike, AL7MI, is a ham who is presently attending the University of Alaska working on his education degree while doing work at a local elementary school, where amateur radio is being used as a motivational tool.

Al, AA3EH, is an administrator in a high school in Pittsburgh, where the recently developed technology plan includes amateur radio as a technology club.

Brandon, N0XJY, is a 9th grade student at Waco High School in Wayland, Iowa, where amateur radio is an extra–curricular activity and they have 12 licensed operators, including students, teachers and bus drivers.

Jim N0OFQ, and his wife Marian N0YMJ, from Yutan, Nevada, are in the process of explaining to administrators the benefits of amateur radio in the classroom, and Marion is now setting up a packet radio station in her 5th grade classroom.

Ken, KG8DN, who oversees the 'ham shack' at Gilmour Academy in Gates Mills, Ohio, sent a list of 10 other amateurs involved in education. That list included Bob, K8RBV, who teaches computers in Shaker Heights, Ohio; Tim, WD8PDV, a technician at NASA–Lewis, who provides video and ham communications to Bob and Chris (waiting for his license to arrive), who do simulated space shuttle missions with their students; Jim, AA8DB, a Franciscan monk and administrator in Parma, Ohio, who oversees an active ham club at Padua High; and Don, K9WI, a Holy Cross Brother at St. Edward University in Austin Texas. Don subsequently sent some information about amateur radio at St. Edwards. There, they use amateur radio in a course called Radio Communication and Electronics. It is a credit course recognized by the communications and physics departments.

Bob, KB8AST, sent a list with over 40 call signs, mostly in New York and surrounding areas, connected in one way or another to education. Subjects from industrial arts and technology to criminal justice to computer technology were listed. The call for the Brooklyn Tech High School was included in a list of schools ranging from elementary to community college level. And this was just a subset of his total list of over 320 call signs world–wide.

Rick, WA2HYQ, described how his school in Connecticut converted a teacher prep room to house the school amateur radio station. This was done so that licensed students could use the equipment without interfering with a class in progress in the technology classroom where the program got it's start. All teachers have access to the club and are encouraged to use the services available.

These are only a few of the many examples of how amateur radio is enhancing educational curriculum. There are many more. The American Radio Relay League can help educators who wish to use amateur radio in their classrooms, by providing instructional material, ideas, and the names of amateurs interested in volunteering their time and expertise in support of education.

SUMMARY:

Far from being only a technical hobby enjoyed by a small group of electronics experts, amateur radio is a world–wide activity that involves people from widely varied backgrounds. It is as much a social activity as a technical one. It involves academic or "hard" skills as well as social or "soft" skills.

Amateur radio has a lot to offer both academic and vocational education. In fact, one of its reasons for existence, as stated by the FCC, is for education and training. It can help motivate students by providing a fun, interesting and somewhat unique activity for both technically and socially oriented students, it can provide concrete examples and applications for academic subjects, and it can help decrease the isolation that tends to occur in the school.

The calls for more infusion of vocational awareness and training into academics are being heard from all sectors of education, business and government. The increasing complexity of technology is requiring more academic rigor in vocational education. Amateur radio can help support both of these objectives.

Educators with vocational–technical backgrounds are the natural choices to help implement the use of amateur radio in support of education, both academic and vocational. Vocational educators, by virtue of their real–world orientation and technical knowledge, have the an opportunity not only to use amateur radio as part of a specific vocational course or program, but to offer it to other educators as well. This can provide the benefits of ***enhancing both academic and vocational curriculum***, better preparing those students who choose a vocational program, and promoting vocational and technical programs, all at the same time.

For more information, the reader is encouraged to contact the author, the American Radio Relay League, or their local amateur radio club.

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Note: Characters in brackets (i.e. "[KC2WI]") indicate amateur radio call signs. This information is included to show amateur radio involvement in education.