2020 VISION: *"Changing the Face of Education in Fayette County"*

WORK GROUP: *Science and Technical Education*

FINAL REPORT

Committee Members:

Jock Gum	Deb MacKay	Lissa Pohl	Mark Williams
Naresh Shah	Michael Sheetz	Amy King	Pamela Trautner
Steve Senft	Alison Soult	Mark Manuel	Vicki Brown

Number of Specific Recommendations: ___4___

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These proposals are designed to prepare our kids for the futures they will face. The result will change the means of delivering Science Education and Technical Education by enhancing the ability for each student to learn, while providing all students with the problem-solving and critical thinking basis they need to compete in the global marketplace.

The first issue our group had to address was how to tackle the broad and seemingly divergent topics of *Science Education* and *Technical Education*. We discussed separating into two groups or sequentially focusing on Science Education, then Technical Education (or vice versa), and then on the intersection of the two. Ultimately, the group concluded that we would solely focus on the intersection, and in fact, we begin with the recommendation that the two be merged into one aspect of school curriculum, entitled **Integrated Sciences**. **Integrated Sciences** includes general sciences as well as applied sciences, and is intended to provide all FCPS students a balanced, comprehensive, and comprehendible background in science theory and application.

Our students will be well prepared to pursue careers as craftsmen, scientists, researchers, engineers, tradesmen, medical professionals, educators, or a variety of other options because they will have a solid foundation in the basic theories of sciences, the scientific method, and a working knowledge of how things work.

The education will be completed with a Senior Project that includes the application of principles and theory in a student-selected area of interest – ranging from optics to bio-agriculture to automotive electronics to welding to gene therapy to kitchen science to construction, etc.

Throughout the school years the students will participate in hands on experimentation to help them discover and understand the principles of various science disciplines.

Further, this work group proposes that the **Integrated Sciences** education be delivered to students in a building block or helical approach with the various science disciplines and principles being introduced in the early years and then repeated and expanded in Middle School and again in High School. This serves to reinforce the learning and expand the comprehension as the students develop cognitively. Principles are demonstrated in concrete forms the early years and more abstractly in the later years when the students' cognitive development supports the understanding.

Finally, teacher qualification and providing an environment for learning are the concluding essentials for the proposal set. All four proposals are intended to result in knowledge and comprehension in all the kids, so that they have flexibility in their choices of future work, volunteer activities, and their well being. It is all about these kids and their futures.

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Group Recommendation Number: ___1____

Specific Recommendation: Integrate all science disciplines and technical education and eliminate the separate entities.

In the 2020 Science program we will teach applied science to all students. All Technical Education/Career and Occupational training will also be taught as science. To extend the integration and enhance the education experience the senior year of High School is totally focused on applied science education for all students.

This integrated curriculum will be renamed **Integrated Sciences**.

Experiences at all levels will include field trips, demonstrations, and hands-on learning. The integration includes physics, chemistry, biology, earth science, geophysics, ecology, environmental science, energy, finance, economics, computer sciences, transportation, communication, material sciences, optics, agriculture, and all technical applications of these science subjects, plus mathematics, reading and writing, especially technical writing.

This will provide real world application and experiences for all students to reinforce comprehension of theory, just as theory enhances the comprehension of real world experiences.

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Group Recommendation Number: ___1____ (Integrate Science and Technical Education)

Research Rationale for how this change will help kids:

Increasing the opportunities for hands-on experiences aligns with National Science Reform and helps students learn better. (*Integrating Science Education and Career and Technical Education in Brief: Fast Facts for Policy and Practice No. 3*; Maurer; 2000) Students who learn better grasp the concepts and can apply then in new situations, not just repeat facts and solve a limited set of problems. This prepares our kids for the challenges of the world they will face in the middle of the 21st century. They will have flexibility in future career choices and the problem-solving and critical thinking skills to compete on a global level.

For students who traditionally take courses on the Technical Education track, this proposed integration will improve the educational experience. The new program:

- Demonstrates academic rigor in the career and technical education program.
- Provides a solid academic foundation for all students – most students will then be able to adapt to changes in the economy and job options that may require learning new skills.
- Eases the transition to post secondary education or advanced training that most high demand, technical occupations require.

(*Charting a New Course for Career and Technical Education*, U.S. Department of Education,)

Additional benefits for students on the former Technical Education track include:

- Vocational students who completed challenging curriculum have higher achievement on test scores. In turn, this outcome may lead to increased self-esteem and possible scholarships or acceptance in the most demanding post secondary programs.

(*The Role of Career and Technical Education in High School*; Miller; 2002)

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Group Recommendation Number: ___1____ (Integrate Science and Technical Education)

Additional references for the "hows" and "whys" of this proposal are:

Curriculum development, linking science education to life : report of a SubRegional Workshop on Designing and Developing Inovative Science Curriculum and Instructional Materials, Bangkok, 8-20 December 1980. (1981). Bangkok: Unesco Regional Office for Education in Asia and the Pacific.

Patton, P. G., & Payne, C. A. (1999). Integrating technology into the science curriculum : intermediate. Westminster, CA: Teacher Created Materials, Inc.

Thompson, B., & Roots Activity Learning Center. (1994). (African-centered interdisciplinary multi-level hands-on science AIM hands-on science curriculum) : preprimary-8th grade. Washington, D.C.: Roots Activity Learning Center.

Robert C. Wicklein and John W. Schell, (1995).Case Studies of Multidisciplinary Approaches to Integrating Mathematics, Science and Technology Education. *Journal of Technology Education* ,Volume 6, Number 2, Spring 1995

Jump-starting a model for curriculum integration September 10, 2003 NYSUT.org. Copyright New York State United Teachers. 800 Troy-Schenectady Road, Latham, New York, 12110-2455. 518.213.6000. http://www.nysut.org.

Integrating Science and other curriculums with technical education in Nevada see - http://www.ccsd.net/cpd/career_teched/9_12/acadinteg.

Office of Vocational and Adult Education - htmhttp://www.ed.gov/about/offices/list/ovae/pi/hs/mse2.html

Integrating Science and Math in Vocational Education. ERIC Digest.http://www.ericdigests.org/1993/math.htm

Crismond, D., Carlyon, E & Wedding, K. Essential Building Blocks: A Look at Technology for Science. (1996) Hands On! TERC. Cambridge, MA.

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Implementation Steps for Recommendation # 1 Integrate "Science" and "Technical Education" into Integrated Sciences	**Person Responsible for Completing Steps**	**Possible Resources?**	**Start Date**	**End Date**
Establish advisory committee of "customers" of the students; identify the Advisory Committee Chair	School Board and Administration	Colleges, local business	Jan 2006	
Rename the integrated curriculum and publicize the change (marketing activities)	FCPS Administration	FCPS Instructional Course Directories; local media	mid 2006	
Identify leaders for Integrated Sciences for the school system for Elementary, Middle, and High School (3 people)	FCPS Administration	Current staff; national search	mid 2006	
Develop the detailed curriculum, phasing in over 3 school years	Advisory Committee Chair with Integrated Sciences Leaders	Current curriculum as reference; NSF standards	2006	2008
Implement the new curriculum, phased in	Integrated Sciences Leaders and teachers		2006	2009
Provide mandatory training for all Integrated Sciences teachers, to help facilitate the change	Integrated Sciences Leaders	Dufour and Eaker: Professional Learning Communities at Work: Bets Practices for Enhancing Student Achievement, 1998	2006	2006
Establish list of field trips, hands-on activities and demos as a teacher resource to supplement daily teaching	Integrated Sciences Leaders and teachers	CommerceLexington, local businesses, UK	2006	2008

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Group Recommendation Number: ___2____

Specific Recommendation: Implement a building block approach to the Integrated Sciences curriculum.

See the example below for a progression of concepts (helical learning model) from Elementary to Middle to High School. The curriculum is to focus on concepts, principles, application, and analytical thinking. Students will develop the ability to grasp the concepts at each cognitive development stage. The curriculum will Include a Senior Project that is an applied science project assimilating various science disciplines with a focus that matches the student's interest and career aspirations.

Helical learning of science topics

	Elementary	Middle School	High School (includes ideas for Senior Year project)
Materials Cutting	Scissors, paper punches, knife	Wood/metal saw, Drill, wood lathe	Lathe, electron beam/laser cutting CNC machines
Materials joining	Scotch tape, glue	Nails, rivets, adhesives	Electric arc/TIG Welding, spot welding (autos), fastening dissimilar objects/materials
Materials shaping/building	Play dough, Lego/Kinex/mechano blocks	Wood lathe, pottery, glass blowing	Senior project e.g. build a dining table, wheelchair
Optics	Magnifying glass/telescope	Optical microscope Polarized light	Electron microscope Confocal microscope Radio astronomy
Communication	Library, newspaper, telephone	AM/FM/satellite radio, UHF/VHF/cable/satellite TV	GPS Telemetry for space probes
Transportation	Bicycle, cars	Trains, planes	Space shuttle, submarine, Segway
Chemistry	Volcano, elephant toothpaste, fireworks	Acid/base reactions	Polymers, fertilizers Kitchen chemistry, cosmetics
Energy	Solar/wind power	Natural gas/coal combustion	Fuel cells, nuclear energy
Biology	Insects/plants, Why brush teeth, wash hands before eating?	Human organs, skeletal, muscular systems, diseases	Gene therapy, prosthesis, surgery, Cures for diseases

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Group Recommendation Number: ___2____ (Building Block Approach to Integrated Sciences Curriculum)

Research Rationale for how this change will help kids:

See (*Science Content Standards*, National Academy Press, 1996)

Additional resources for further understanding and implementation include:

VanTassel-Baska, J., Gallagher, S. A., Damiani, V. B., & College of William and Mary. Center for Gifted Education. (1997). Guide to teaching a problem based science curriculum. Dubuque, Iowa: Kendall/Hunt.

Bybee, R. W., & Backe, R. (1996). National standards and the science curriculum : challenges, opportunities, and recommendations. Dubuque, Iowa: Kendall/Hunt Pub. Co.

Kraus International Publications. (1992). Science curriculum resource handbook : a practical guide for K-12 science curriculum. Millwood, N.Y.: Kraus International Publications.

Adeyemi, M. A. (1995). Curriculum change and innovation : impact on science curriculum projects. Ipaja, Lagos: Deutchetz Publishers.

Curriculum development, linking science education to life : report of a SubRegional Workshop on Designing and Developing Inovative Science Curriculum and Instructional Materials, Bangkok, 8-20 December 1980. (1981). Bangkok: Unesco Regional Office for Education in Asia and the Pacific.

California. State Board of Education., & California. Science Curriculum Framework and Criteria Committee. (1990). Science framework for California public schools, kindergarten through grade twelve. Sacramento, Calif.: California Dept. of Education.

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Carin, A. A., Bass, J. E., & Contant, T. L. (2005). Methods for teaching science as inquiry (9th ed.). Upper Saddle River, N.J.: Pearson/Merrill Prentice Hall.

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Handwerke, M. J. (1999). Ready-to-use human biology & health activities for grades 5-12. West Nyack, N.Y.: Center for Applied Research in Education.

Handwerker, M. J. (1999). Ready-to-use chemistry activities for grades 5-12. West Nyack, N.Y.: Center for Applied Research in Education.

Handwerker, M. J. (1999). Ready-to-use life science activities for grades 5-12. West Nyack, N.Y.: Center for Applied Research in Education.

Handwerker, M. J. (1999). Ready-to-use earth & astronomical science activities for grades 5-12. West Nyack, N.Y.: Center for Applied Research in Education.

Handwerker, M. J. (1999). Ready-to-use physical science activities for grades Handwerker, West Nyack, N.Y.: Center for Applied Research in Education.

Co. Herr, N., & Cunningham, J. B. (1999). Hands-on chemistry activities with reallife applications. West Nyack, N.Y.: Center for Applied Research in Education.

Keeley, P. (2005). Science curriculum topic study : bridging the gap between standards and practice. Thousand Oaks, Calif.: Corwin Press.

Liu, X. (1996). Mathematics and science curriculum change in the People's Republic of China. Lewiston, N.Y.: Edwin Mellen Press.

Patton, P. G., & Payne, C. A. (1999). Integrating technology into the science curriculum : intermediate. Westminster, CA: Teacher Created Materials, Inc.

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Tolman, M. N. (1999). Hands-on science activities for grades K-2. West Nyack, N.Y.: Parker Pub. Co.

Tolman, M. N. (1999). Hands-on science activities for grades 3-4. West Nyack, N.Y.: Parker Pub. Co.

Tolman, M. N. (1999). Hands-on science activities for grades 5-6. West Nyack, N.Y.: Parker Pub. Co.

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Implementation Steps for Recommendation # 2 **Building Block approach to curriculum**	**Person Responsible for Completing Steps**	**Possible Resources?**	**Start Date**	**End Date**
Establish committee to evaluate the current curriculum (What is being taught and how is it being taught)	School Board and Administrative Office	Committee from recommendation #1; include teachers of science, technical education, mathematics; as well as experts from outside the school system who are employed in the areas of applied science and technology	January 2006	May 2006
Establish committee to redesign the curriculum	Administrative Office		January 2006	
Phase the curriculum into the school program	Integrated Sciences Leaders and teachers	Helical learning model	August 2006	August 2009
Develop assessment process and standards for student achievement and advancement	Standards Committee		Jan 2006	May 2006
Define criteria for senior projects	Integrated Sciences Leaders and teachers		June 2006	May 2006

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Group Recommendation Number: ___3____

Specific Recommendation: Set higher standards for qualification for Integrated Sciences teachers – elementary, middle, high school.

- For current teachers in the Integrated Sciences, provide hands on experiences in the subject they teach.
- Set clear criteria for who is eligible to teach a subject matter as part of the hiring process. High School Integrated Sciences teachers should have Masters of Science or the equivalent technical expertise qualifications (example Master Plumber) in the subject they teach.
- Establish a means of attracting and retaining qualified teachers. (focus groups for attraction and retention)
- Establish a co-op of instructors from university, local businesses, and among FCPS teachers to teach in areas of their expertise.
- Assess the PD program effectiveness, as it relates to the on-going qualification process. Include coop, lab experiences for teachers in summer as development activities.
- Assess instructor's performance from multiple aspects (peers, parents, next level teachers, etc.) not simply from standardized test scores

Research Rationale for how this change will help kids:

K-12 and Postsecondary Educators Must Forge Stronger Ties To Enhance Teacher Education and Professional Development In Science, Mathematics, and Technology The National Acadamies at http://www4.nationalacademies.org/news.nsf/isbn/0309070333?

Science Teacher Preparation and Career-long Development, Association for the Education of Teachers in Science (ASTE) see - http://aste.chem.pitt.edu/positionpapers/AETSPosnStatemt1.htm

California Mathematics and Science Partnership Grant Program see http://www.cde.ca.gov/pd/ca/sc/

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Implementation Steps for Recommendation # 3 **Higher standards for teacher qualification**	**Person Responsible for Completing Steps**	**Possible Resources?**	**Start Date**	**End Date**
Establish a committee for setting standards	School Board and Administration Office	Teachers, principals, parents, students	Jan 2006	June 2006
Develop assessment for teachers	Qualification Standards Committee		Jan 2006	On going
Develop assessment for PD program	Qualification Standards Committee		Jan 2006	On going
Define incentive package for recruiting and retaining – include opportunities for summer research or technology related experiences	School Board and Administrative Office		Jan 2006	
Develop source list for hands on summer experiences	Qualifications Standards Committee	Commerce Lexington; UK; other scientific businesses	Jan 2006	
Develop core of part-time faculty (citizen instructors) to teach selected, advanced courses in which there are an insufficient number of qualified teachers available	Qualifications Standards Committee	Community partnerships workgroup	Jan 2006	

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Group Recommendation Number: ___4____

Specific Recommendation: Establish an environment for learning so that problem-solving and analytical thinking skills will be developed

- Consider expectations of both students and teachers
- Upgrade labs and resources (establish partnering with industry to get the equipment)
- Promote authentic connections with the students
- Reduce class size
- Maximize the time for learning
- Establish expectations and accountability for student behavior during the school day

Research Rationale for how this change will help kids:
A great deal of research is available o the topic of providing an effective environment for learning. Some sources for consideration include:

Dumbing Down our Kids: Why American Children Feel Good About Themselves But Can't Read, Write or Add, by Charles J. Sykes, St. Martin's Press, New York, (1995)

The Feel - Good Curriculum: the Dumbing – Down of America's Kids In The Name Of Self-esteem by Maureen Stout (2000)

Community Building: Renewing Spirit & Learning edited by Godz (1995)

The Rights Of All Our Children: A Plea For Action by Evans Clinchy (2002)

Goodrich, H., & Harvard Project Zero. (1995). Teaching through projects: creating effective learning environments. Menlo Park, Calif.: Innovative Learning Publications.

Goh, S. C., & Myint Swe, K. (2002). Studies in educational learning environments : an international perspective. Singapore ; River Edge, NJ: World Scientific.

Freiberg, H. J. (1999). School climate : measuring, improving, and sustaining healthy learning environments. London ; Philadelphia: Falmer Press.

Corte, E. d., & European Association for Research on Learning and Instruction. (2003). Powerful learning environments : unravelling basic components and dimensions (1st ed.). Amsterdam ; Boston: Pergamon.

Longworth, N. (2003). Lifelong learning in action : transforming education in the 21st century. London ; Sterling, VA: Kogan Page.

Tokoro, M., & Steels, L. (2004). A learning zone of one's own : sharing representations and flow in collaborative learning environments. Amsterdam Washington, DC: IOS Press.

Logrippo, R. (1995). In my world : designing living & learning environments for the young. New York: Wiley.

Frank, T. H. (2005). The handbook for developing supportive learning environments. Larchmont, N.Y.: Eye on Education.

Dohmen, G. (1998). The future of continuing education in Europe : lifelong learning for all, in changed learning environments. Bonn: Federal Ministry of Education and Research.

Ysseldyke, J. E., & Christenson, S. (2002). Functional assessment of academic behavior : creating successful learning environments. Longmont, Colo.: Sopris West.

Levin, J., & Shanken-Kaye, J. M. (2002). From disrupter to achiever : creating successful learning environments for the self-control classroom. Dubuque, Iowa: Kendall/Hunt Pub. Co.

Washington, DC: George Washington University Graduate Hurtado, S., ERIC Clearinghouse on Higher Education., & Association for the Study of Higher Education. (1999). Enacting diverse learning environments : improving the climate for racial/ethnic diversity in higher education. Washington, DC: George Washington University Graduate School of Education and Human Development.

Strange, C. C., & Banning, J. H. (2001). Educating by design : creating campus learning environments that work (1st ed.). San Francisco: Jossey-Bass.

Isbell, R. T., & Exelby, B. (2001). Early learning environments that work. Beltsville, MD: Gryphon House.

Tomlinson, C. A. (1999). The differentiated classroom : responding to the needs of all learners. Alexandria, Va.: Association for Supervision and Curriculum Development.

Baker, B. M., & Heyning, K. E. (2004). Dangerous coagulations? : the uses of Foucault in the study of education. New York: P. Lang.

Obiakor, F. E., & Ford, B. A. (2002). Creating successful learning environments for African American learners with exceptionalities. Thousand Oaks, Calif.: Corwin Press.

Herman, T. M. (1977). Creating learning environments : the behavioral approach to education. Boston: Allyn and Bacon.

Wellhousen, K., & Crowther, I. (2004). Creating effective learning environments. New York: Delmar Learning.

Widodo, A. (2004). Constructivist oriented lessons : the learning environments and the teaching sequences. Frankfurt am Main ; New York: P. Lang.

Wilson, B. G. (1996). Constructivist learning environments : case studies in instructional design. Englewood Cliffs, N.J.: Educational Technology Publications.

Jones, V. F., & Jones, L. S. (1995). Comprehensive classroom management : creating positive learning environments for all students (4th ed.). Boston: Allyn and Bacon.

Zabel, R. H., & Zabel, M. K. (1996). Classroom management in context : orchestrating positive learning environments. Boston, MA: Houghton Mifflin.

Herrington, A., & Herrington, J. (2005). Authentic learning environments in education.

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Implementation Steps for Recommendation # 4 Establish an environment for learning	**Person Responsible for Completing Steps**	**Possible Resources?**	**Start Date**	**End Date**
Perform a study of teaching time effectiveness of a typical day for each level, with the intention to raise effectiveness and productivity	Internal or External Consultant	All teachers, principals with administrative support	August 2006	December 2006
Develop a plan to increase the hours of actual learning time	School Board and Main Office	Teacher, parent, student and administrative (board) focus groups	January 2007	May 2007
Reduce class sizes	School Board and Administration	Teachers and Principals	ASAP	
Partner with industry for lab equipment	Community Resource people	Commerce Lexington; University of Kentucky	January 2006	
Market, advertise the value of science	Focus Groups and Administrative Office	Local "school friendly" marketing agencies	May 2006	
Use multimedia, including TV shows such as Newton's Apple; Zoom; Bill Nye, the Science Guy in the classrooms	Educational Ombudsman and resource people at each school or through the main office	Foundation grants and funding (ex. www.nsf.gov)	Align with new curriculum	
Establish behavior expectations and accountability	Main office and each school	Use and revamp current guidelines with input from parents, students, teachers, and principals	January 2006	

- End of Report -