IPRO 330

Grant Proposal

NSF—Math and Science Partnership (MSP)

Spring 2009

Project Summary

The Science and Math Learning Center (SMLC) is proposed to be established based on the knowledge gained in this area with the proposed lead partner being Greg Fasshauer (PhD.) with the additional lead core supporting partner(s) being Mr. Jose Barrera from Columbia Explorers Academy, Ms. Ana Martinez Estka from Avondale Junior High, and Mr. Syed Ahmed, from McPherson school. Throughout the past five college semesters dating back to spring, 2007, an Interprofessional project team at the Illinois Institute of Technology (IIT) has collaborated within the CPS district through science fair participation as well as extensive communication within and external to CPS. Throughout this time experience has been gained and ultimately it has been observed that in general, the CPS students lack the numerous resources prohibiting them from having a strong foundation in math, science and technology. This proposal attempts to address a deficiency in practical experience and resources available to Chicago Public School (CPS) students in the context of their science fair projects as well as background in math and sciences by a collaborative effort between three committed CPS schools and the Illinois Institute of Technology (IIT). To encourage students' participation in STEM careers, the SMLC, a dedicated lab, will be created as a place for CPS student growth in his/her understanding and enjoyment of math, science, and technology. The lab will be facilitated by IIT students and a faculty advisor who will instruct and manage the lab. The participating teachers from the schools (6-12 grade range) would be in attendance with their classes (potentially 20-25 students) to handle disciplinary issues if necessary and to also add to the instruction. The main goals for this proposed project are, first we hope to have an increased enrollment of CPS students to IIT in math, science and engineering disciplines. We also expect an increase in science fair competition and the overall number of students participating. For teachers, we expect an increase in the level of classroom instruction, with their students being exposed to a wider array of science and math problems. A few years from now, the SMLC will become (based on support and demographics) a successful non-profit learning center serving the local Chicago land area providing education, opportunity, and the necessary resources to help foster and promote the future advancement of science and math in CPS schools but more importantly through the underprivileged students to assist them for the rigorous college learning endeavors.

Project Description

The Science and Math Learning Center (SMLC)

Vision, Goals and Outcomes

Since 1995, the Interprofessional Project (IPRO) program at the Illinois Institute of Technology (IIT) has offered courses specifically intended for its undergraduate students from various academic disciplines to gain problem-solving experience by collaboratively tackling real-world problems. One particular group's overarching goal is to enhance and stimulate the learning of science and math among students, particularly those in Chicago Public Schools (CPS). To achieve this goal, we targeted a common medium through which many students engage in scientific learning: science fairs. For five semesters, we have developed, maintained, and promoted a website intended to serve as a resource containing science fair project ideas, information on conducting a successful science experiment, and advice on communicating the results effectively.

Despite all of our previous work, our partnership with CPS has been constrained by space, time, and financial resource limitations. Many other steps have been taken over the past two years to gather more information about ways to enhance learning through parent and teacher interaction at science colloquia and surveys, while providing service to CPS by volunteering at science fairs and other organizational opportunities. Recently, our team has reached out beyond our website and science fairs to numerous interested parties at CPS (administrators, teachers, and parents) and in the IIT community. There has been a large amount of interest shown, support, and feedback that allow us to focus more realistically on our developing vision of including IIT the entirety of IIT and CPS in a comprehensive, long-lasting relationship of developing young students' interest in math and science as well involving college students in the process of math and science education.

In an effort to make our previous work more impacting, we propose constructing a lab at IIT, the Science and Math Learning Center (SMLC), for middle and high school students to receive direct help in math, science, and engineering disciplines with at first an emphasis on

formulating a quality science fair projects, which will provide a grounds for further development of the understanding of the nature of math, science and engineering. This will be accomplished with the assistance of IIT undergraduate students working directly with CPS students in a learning-intensive environment. Our proposal directly addresses a deficiency in educational resources available to Chicago Public School (CPS) students to make successful science fair projects. It is our hope that the SMLC will become a successful non-profit learning center capable of providing the necessary resources to help foster and promote science and math in CPS schools as well as encourage student interests in STEM careers. Despite the greater aim of the proposal, it is particularly geared towards providing underprivileged CPS students with technological and educational resources which are not readily available at their schools with the assistance of IIT engineering and science students.

The SMLC will be multifaceted, and we expect several outcomes. First, we hope to have an increased enrollment of CPS students to IIT in math, science, and engineering disciplines. We also expect an increase in science fair competition and the overall number of participating students. For teachers, we expect an increase in the level of classroom instruction, with their students being exposed to a wider array of science and math problems with the hope that the teachers then can implement some of what the students do in the lab into their daily classroom curriculum.

Research and Implementation Framework

The SMLC would be unique to the Chicago area, since no such space or program exists with other Chicago universities and CPS. In the U.S., similar programs exist, namely ISEK, Iowa State Engineering Kids, as well as multifaceted outreach programs at Duke University, Tulane University, and the University of Illinois. The resources of the lab would only be available to CPS and its affiliates. The data suggest that urban public schools are not progressing academically and are not hiring the best teachers in the field. The teacher demographics (see Supplemental material) for the participating schools show a need for the SMLC, indicating the lack of time teachers have to instruct students in math and science. Standardized test scores in math and science further corroborate the need for the SMLC. Expectedly, only a small

percentage of CPS students participate in science fairs. We support the involvement of students in science fair projects as it is one avenue to apply science concepts learned in class, but to also apply knew ideas and adapt to non-ideal situations, which is more reflective of actual scientific research and in line with the inquiry-based approach to learning and discovery favored by many today.

Through the numerous schools and people that we have contacted in the past, there is large support for the idea of this learning lab. Upon the SMLC's establishment, the student teachers and the faculty member will to advertise this lab as much as possible via newspapers, internet, and any other types of communication that student parents and/ or teachers will see and eventually endorse. With the construction of this learning lab, the main objective or goal would be to increase the basic knowledge of math and science of young CPS students and overall gradually or significantly increase the participation of schools in science fairs.

The SMLC will hold lab sessions every week. The most effective way that we plan on achieving these goals is to advertise frequently and potentially have school field trips. Due to the fact that there will be student workers from the IIT working in the lab, they have class schedules and there will be certain block periods where the learning center will be open. Therefore, a class of students including teacher can visit during school hours as a field trip. Transportation to and from the SMLC is provided via our budget. This will be the most effective and logical way to get as many students participating in the lab because of the coordination of the supporting teacher, the parents, and IIT

The SMLC will have a well-structured curriculum containing intriguing and mind-stimulating experiments for the K-12 grades to perform on their own with the three modules that we present: Logic circuits, Spectrophotometry, and Rate of Filtration (see Supplemental materials). The logic circuits module introduces students to basic electronic circuits and how to design a circuit with a given function in mind. Spectrophotometry module is a explorative activity where students will investigate the use of a common scientific instrument, the spectrophotometer, with simple solutions of different concentrations. The rate of filtration experiment is also very open-ended, but less sophisticated. Students will see study the effects of type of liquid and filter material on the rate of filtration. The experiments will be there for the students, the student workers will be there to help aid, look over, and prevent damage to any property of the lab or injury to any person in the lab. The students will actively learn the

scientific method while performing the experiments led by the student mentors. From the weekly sessions of the learning lab over a year's time, the participation of schools within science fairs is expected to increase with the increased science instruction and access to physical resources to perform the experiments. The inquiry-based learning center revolves around the motivation of the learner and with the primary goal to intrigue the students with fascinating modules and experiments that will spark the inspiration to learn.

The lab will also aid in the success of students for the transition from elementary to middle school, middle school to college or high school to college from exposure to an extracurricular math and science program that will support communication and responsibility in the student The lab will offer all levels of math and science experiments or tutoring from student workers with an diverse and firm educational background.

This lab aims to improve the resources and increase the knowledge base in math and science of CPS students. This will accomplished through interaction with three CPS schools and their science/math teachers in a test phase. The experience will serve to prepare the students for careers in STEM related fields by reinforcing the essence of those subjects and by giving them experience in scientific investigation via their lab sessions. The experience will also compliment some of the teacher's instructional responsibilities and provide their students with hands-on guidance that may not be present during their normal school day. Teachers may also be able to use the teaching strategies or projects presented at the lab in their own class depending on the topic being presented.

The partnership will initially include only three CPS Schools. Close contacts with administration and faculty at these schools have been made, and their commitment to the SMLC has been attained (see Supplemental materials). These schools will serve as a test phase for the learning center. If successful, the opportunities can be extended to the entirety of CPS students and teachers, thus strengthening the partnership through CPS executive officers. Endorsement of the lab will then be made as well as major changes to accommodate more students, such as the development of more curriculum modules, the recruitment of more student workers, and increased publicity and support from IIT and CPS.

The schools participating are as follows: Columbia Explorers Academy (K-8), Avondale (K-8), McPherson (K-8). The main partner for Columbia Explorers Academy is principal Mr. Jose Barrera. For Avondale: Ms. Ana Martinez Estka, and for McPherson: Mr. Syed J. Ahmed.

The basic teacher data is presented in Table 1 for the three schools. Accompanying this data are test scores and science fair participation for the academic year 2007-2008 (Supplemental documents)

Table 1—Summary of test scores and teacher data for three participating schools

			McPherson	Avondale Elementary	Columbia Explorer's Academy	City Wide
ISAT Math % Exceeded	Grade	3	34.1	15.4	21.6	24
		5	3.3	3.9	2	9
		8	20	n/a	24	15.8
ISAT Science %Exceeded		4	9.1	14	1.8	7.6
		7	11.1	n/a	3.4	8.9
Explore Math %Exceeded	Mean		13.6	n/a	14.1	13.4
	Total Tested		68	n/a	87	28090
Explore Science %Exceeded	Mean		15.6	n/a	15.9	15.4
	Total Tested		68	n/a	87	25255
Instructional Settings	Average Class Size per Grade	1	21	21	25	
		2	20	22	29	
		3	29	23	25	
		4	32	24	28	
		5	27	25	32	
		6	21		31.8	
		7	20		27.3	
		8	25		31	
	Time Devoted to Science [min]	3	48	60	48	
		6	53	0	53	
		8	53		55	
	Time Devoted to Math [min]	3	24	24	24	
		6	40		40	
		8	40		40	
Teacher Information	# of Teachers with Degree	Bachelors				
		Masters				
	% of Classes not Taught by Highly Qualified Teachers		25	34.8	33.3	

Evaluation Plan

The evaluation is broken into three sections: participating students, IIT student-mentors, and partner institutions. Each part describes assessment strategies and methodologies used to evaluate each party.

Evaluation Plan for Participating Students

In our inquiry-based lab setting, we provide visiting CPS students with an environment to facilitate their projects. One of our goals is that CPS students learn the fundamentals of scientific

inquiry and the scientific process as well as the theory behind their projects. One of the challenges of inquiry-based learning methods is developing an effective evaluation strategy with common assessment criteria, since much of inquiry-based learning revolves around the motivations of the learner.

Thus, our evaluation strategy for participating students is two-pronged. We will monitor test-score statistics, specifically science and math, from students in participating schools to assess the efficacy of theory-centered teaching within the laboratory environment. To evaluate projects, we primarily rely on qualitative methods, which focus on process-driven and attitude-based assessments, rather than quantitative test-score outcomes. However, in order to drive the science fair theme we will also be able to compare the beginning and end participation rates in school/district/citywide science fairs as a quantitative measure towards the lab's success.

Qualitative Assessments

Qualitatively, we evaluate participating students' process-driven skills based on their ability to observe physical phenomena, formulate appropriate hypotheses, and make relevant predictions based on the experimental data and scientific theory. We also evaluate the students' ability to plan and conduct a scientific investigation, interpret evidence, draw conclusions, and communicate effectively. Process-driven skills, qualitatively evaluated by co-PIs and IIT student-teachers, are those under examination by science fair project evaluators. This is where the quantitative participation rates will help gauge a change.

The second component of our qualitative assessment program will evaluate the attitudes of the participating students. The following checklist of questions, based on a 1997 study by Harlen and Jelly, will be used to aid the attitude-based evaluation process.

1) Is the approach/hypothesis relevant and useful, even if the details require further refinement?
2) Does the student account for controls and variables?
3) Does the student have a strategy to obtain the actionable data?

4) Did the student develop methods to compare and evaluate data from multiple trials/experiments?
5) Did the student take appropriate steps to maximize accuracy?
6) Were appropriate efforts taken to produce thoughtful interpretation of the data?
7) Did the student show patience and perseverance?
8) In the group setting, did the students make efforts to share the tasks evenly, and did all students show similar levels of effort?

Within the framework of this checklist, IIT student-mentors will make qualitative evaluations. Moreover, participating students will have the opportunity to evaluate each other based on similar criteria. The attitude-based assessment focuses on evaluating the effort and attitude of participating students, rather than their achievements.

Quantitative Assessments

Quantitative assessments serve as a long-term evaluation strategy based on standardized test scores and science-fair participation levels. As detailed in our Supplementary Data, we consider the standardized test scores (ISAT, EXPLORE, ACT) of Chicago-area Public School students from the last several years. We focus on monitoring test scores of participating students from the three schools participating. Since our initial, trial-phase year of this project will involve three schools, we will focus on improvements of these test scores for students within these schools. One of our major foci is to help teach the students the science and math fundamentals and theoretical knowledge they will require to help develop and conduct their individual projects, as well as help their long-term success in STEM careers. Based on our teacher data, teachers with strong backgrounds in STEM subjects are scarce in CPS schools, so it is our priority to provide students with an environment to develop knowledge of these subjects and increase exposure to student-mentors with strong backgrounds relevant to the development of this knowledge.

In accordance with this, we will focus test-score improvements on the relevant tested areas. These include math and science scores from the above tests, such as the ACT Math and Science sections. If the data is available, we will try to get more “real-time” results by looking at

individual students' in-class tests in math, science, and technology-centered subjects. Other qualitative measures may be provided at the discretion of the participating CPS teachers. It is our belief that the inquiry-based learning environment will improve both fundamental understanding of these STEM subjects as well as improve the quality of individual students' critical thinking and reasoning processes, and we believe the success of our methods will be borne out in part in standardized test-score improvements.

A significant component of our methods is the inspiration of students to participate further in STEM education and careers; we feel a relevant evaluation technique will be the level of science-fair participation. CPS holds science fairs at the school, district, and city levels. Based on the Supplementary Data, we find participation is found to a high degree in the schools with a significant commitment to education relevant to STEM subjects when compared to schools with deficient emphasis on these subjects. Given the schools participating in our trial-phase do not currently achieve these participation levels, we feel the efficacy of our methods can be usefully evaluated based on increases in students involved in these science fairs.

By combining the qualitative and quantitative assessments, we believe we have produced a useful metric to evaluate the quality of participating CPS students' experiences in our inquiry-based laboratory setting. This, however, is merely one side of our evaluation process. We also wish to evaluate the quality of the experience being provided by our teachers, and the relevance of this experience to the goals of CPS science, mathematics, and other technology subject teachers. We will continually seek to improve the quality of the experience based on these methods, as well as the efficacy of these methods in inspiring the participating IIT students to pursue STEM careers (both in industry and academics). Our evaluation methods in this regard are detailed in the following section.

Evaluation Plan for Participating IIT Student-Teachers

Ensuring that our teachers are providing a relevant and inspiring learning environment for CPS students is a significant component of our evaluation plan. As detailed in our framework, we will ensure initial quality of the IIT students based on their academic achievement and interviews. They will also be trained by the guidelines provided. However, final evaluations provided to the center director will ensure that our hiring and training processes are producing teachers with the skills to provide the experience described previously.

The final evaluations will consist, in part, of questionnaires provided to the participating CPS students, the participating CPS teachers and institutions, and to the parents of the CPS students. Feedback from these forms will allow us to evaluate and potentially improve our methods constantly as we try to provide an optimized inquiry-based learning environment. These evaluations will be given to the center director, who will make assessments and recommendations based on their results.

Our teacher evaluations also consist of the success of this environment to inspire them to pursue careers in STEM industry and, particularly, education. It is our hope that we hire those with interest in pursuing academic careers in STEM subjects, particularly given significant deficiencies in the number of teachers with specializations in these areas in CPS districts. Part of our evaluation will consist of the number of these student-teachers to pursue these kinds of career paths. The experience will help solidify the teachers' own understanding of these subjects, as well.

Evaluation Plan for Partner Institutions

For participating schools, we believe the learning environment we provide will improve students' theoretical understanding of STEM subjects, and as such the participating schools should see an improvement in the standardized and institution-conducted test scores. For these partner institutions, the success of our methods should be borne out in this form for their benefit. We also hope this will increase matriculation of these students in STEM subjects taught at these schools, as a significant goal of our project is increased interest. We also believe there will be significant gains in the number of students from these partner institutions who participate in CPS science fairs.

For IIT, we hope to increase the number of students matriculating there from CPS schools. Based on the supplementary data, we find a significant deficiency in the ability of IIT to attract local students, particularly from under-privileged districts and under-represented minorities. A severe institution-wide problem is centered upon the inability of IIT to effectively market its significant resources to the local market. One of the goals of our lab is, by exposing CPS students to the facilities, programs, and current students at IIT, we will inspire in them to the desire to pursue their higher studies there.

Partnership Management Plan

In order to meet the goals, expectations, and time constraints associated with the project outline, we will have a strong and well organized management team. The PIs will choose a lab coordinator from interested IIT faculty members. The PI will conduct interviews for the strongest candidates determined from the pool of applicants' CVs/resumes. Hiring criteria are based on previous educational experience, current faculty position, and educational philosophy. Naturally, the advisor should also be passionate about working with young students. The advisor should also demonstrate a high level of organization to handle inventory and lab upkeep, as well as maintain relations with any potential sponsors and visitors.

Responsibilities of the lab coordinator include hiring a team of six student workers and coordinating the visits from local high schools. The lab coordinator is expected to continue teaching at IIT while working for the lab center. The lab coordinator will be in charge of all scheduled events that should occur at the lab. These will include all aforementioned schools attending, open lab time, and any other activities that need to be scheduled in advance. The lab coordinator will also need to have the lab prepared and ready for all events. This will include having proper stock for any materials needed for experiments, making sure all technology is working to ensure that the experience that the attendees receive is scientific, accurate, technologically advanced, and most importantly fun. In order to accomplish some of these tasks, the lab coordinator should delegate some responsibility for the organization and upkeep of the lab to the student workers on duty. This will ensure that they have a designated amount of work to do and also helps them to learn what is needed to properly run a lab teaching session and in this case, one of the prepared modules. Compensation will be provided as a stipend of $2000 per month.

The hiring of student workers will be done as follows. A preliminary screening will be done by having a cumulative GPA (3.25) requirement. A student worker should also have at least one year of college courses in math and science. Anyone who does not meet these preliminary guidelines may request a test to prove their competency in math and science.

The next round of screening will be an interview with the center's advisor which focuses on the student's desire to work in the center and to work with young students, as well as his or her previous educational and tutoring experience. Accompanying this interview will be a test

that covers content as well as strategies for working with younger students. After this stage, the advisor will select students based on the interview as well as his/her content knowledge and experience. Any hired student will undergo background checks as well as any other legal screening with assistance from the Office of the General Counsel.

IIT students will be hired to work with any students in the lab on his/her own personal science project. This requires the student to be flexible and be able to help with different subjects at different times. The student worker will also have to organize and demonstrate the curriculum modules of the lab, if the participating teacher would like his/her students to do so. After presentation of the module, the student worker will have to encourage students' participation in the activity or experiment. Students will also be responsible for maintenance and organization of the lab space, as well as informing the lab coordinator when materials are needed or equipment is broken. Student leads are encouraged to attend science fairs to familiarize themselves with the science fair process. This can give student leads an idea of the strengths and weaknesses of the science fair process and more accurately give help in areas.
Student workers are compensated at $10/hr.

In order for events to run smoothly there will be someone designated to act as events coordinator at the lab. Their role will be to schedule schools accordingly, follow up with them before the day of attending, and keep close communication with attendees on the day of the lab session. This will have to be someone who is organized, and has good communication skills.

The other part of the management team will primarily consist of the co-PIs from the participating CPS schools. For it to be a success, the lab coordinator will have to be in close contact with the principal, science teachers, and parents of the children attending.

The most involved individuals from the school ideally would be the sponsoring teachers of the groups attending; being a certain class or the science club of the school. A science club teacher sponsor can encourage and motivate the students to participate in our lab sessions as part of a monthly planned activity. At the other club meetings, they would either be able to prepare for their lab session with any preliminary material needed, work on science fair projects, and do other small fun activities related to what they did at the previous lab session. As you can see, the sponsoring teacher for the science club and/or science class will need to commit additional time towards the success of this process. However, we plan on motivating the desire to expend this

time by the monetary reimbursement designated and also by the results shown after attending the lab sessions.

Institutional Change and Sustainability

The SMLC possesses the potential to bring about substantial institutional change for both IIT and CPS. By strengthening the relationship between CPS and IIT, CPS students can have a clearer avenue to pursue the first step of achieving a STEM career at the undergraduate level. This can encourage more CPS students to apply to IIT in math, science and engineering-related areas. This will ultimately increase the student size and contribute financially and socially to IIT as a university. Moreover, CPS will benefit from IIT's technological resources.

After the trial year, the success from the three participant schools will be examined. First, more IIT students would be hired to accommodate more students on a more regular basis than once every week or two weeks. Next, more administrative personnel may be needed to maintain the lab center. However, this could be done by a student worker. More curriculum and project ideas will be needed to expand the scope of the lab. It is possible that a school may come twice in a semester, so it is important they do different activities for each visit. To extend the resources of the lab to the entirety of CPS, many changes would need to take place. The organization of the SMLC must change drastically to accommodate a wealth of schools instead of just three.

Strict adherence to the evaluation procedures will be key in determining the success and ultimate sustainability of the center. If the success is very evident through teacher interviews, increased student participation, and overall higher achievement in math and science, an effort will be made to have the center be adopted by IIT, CPS or both, as a fully functioning program supported by both parties. This may take 5-10 years, depending on outcomes and how they are evaluated.

Supplemental Materials

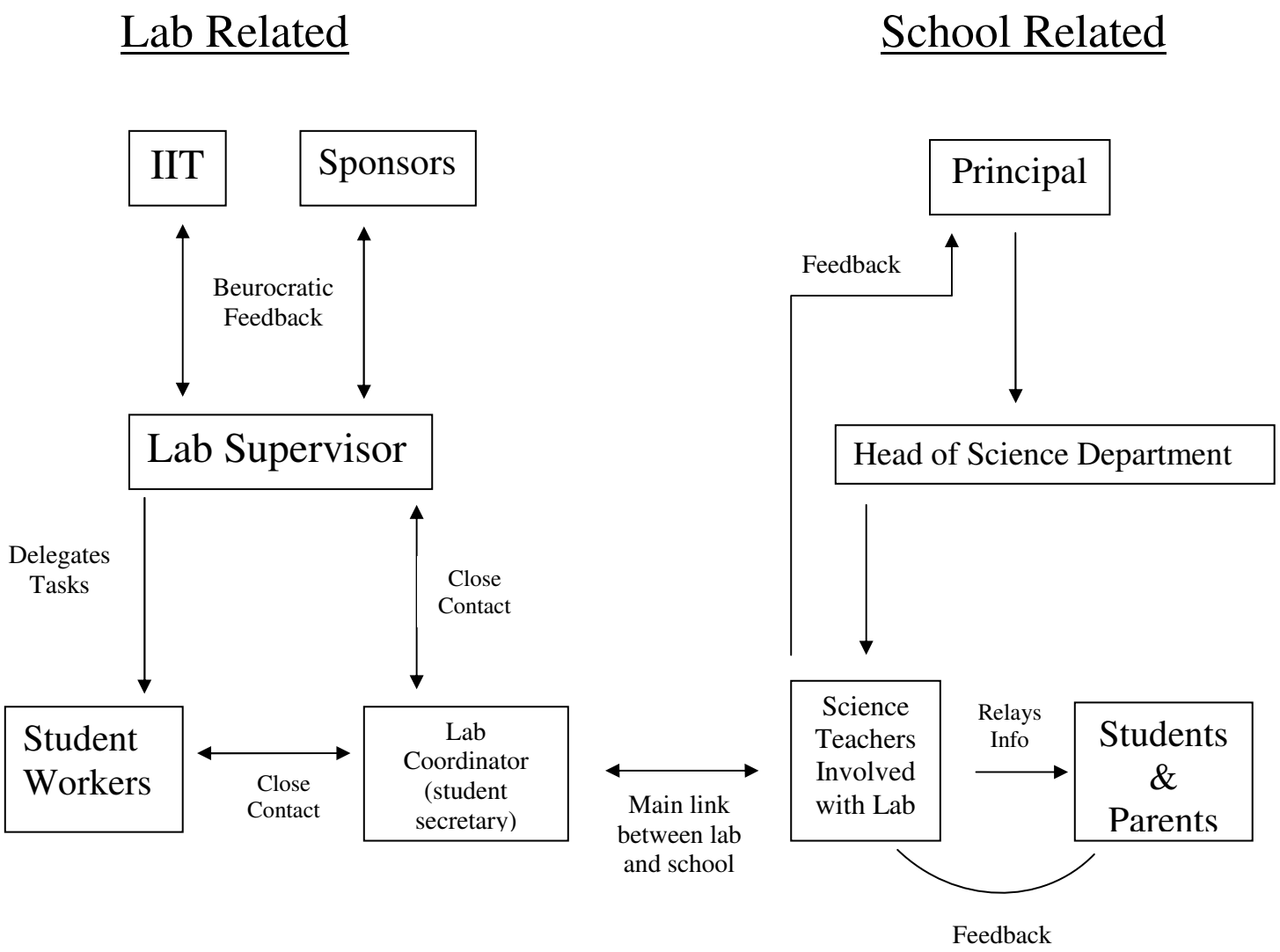
A. Baseline Data

			McPherson	Avondale Elementary	Columbia Explorer's Academy	City Wide
ISAT Math % Exceeded	Grade	3	34.1	15.4	21.6	24
		5	3.3	3.9	2	9
		8	20	n/a	24	15.8
ISAT Science %Exceeded		4	9.1	14	1.8	7.6
		7	11.1	n/a	3.4	8.9
Explore Math %Exceeded	Mean		13.6	n/a	14.1	13.4
	Total Tested		68	n/a	87	28090
Explore Science %Exceeded	Mean		15.6	n/a	15.9	15.4
	Total Tested		68	n/a	87	25255
Instructional Settings	Average Class Size per Grade	1	21	21	25	
		2	20	22	29	
		3	29	23	25	
		4	32	24	28	
		5	27	25	32	
		6	21		31.8	
		7	20		27.3	
		8	25		31	
	Time Devoted to Science [min]	3	48	60	48	
		6	53	0	53	
		8	53		55	
	Time Devoted to Math [min]	3	24	24	24	
		6	40		40	
		8	40		40	
Teacher Information	# of Teachers with Degree	Bachelors				
		Masters				
	% of Classes not Taught by Highly Qualified Teachers		25	34.8	33.3	

B. Proposed Budget

Salaries and Wages						
Position	**Amount**	**Time**			**Total**	
Lab Manager	$2,000	Monthly			$ 24,000.00	
Student Workers	$10	Hour			$ 8,320.00	(approximate)
Teacher Stipends	Average hourly rate from salary or overtime rate if after school	per visit			$ 3,600.00	(assuming each teacher visits once per month for 12 months)
				Net	$ 35,920.00	
Transportation						
Item	**Rate**	**Time**	**Frequency**		**Total**	
Busing--CPS distributor	$250	Roundtrip per visit	4/month for 9 months		$ 9,000.00	
				Net	$ 9,000.00	
Technology						
Item	**Quantity**	**Rate**			**Total**	
Dell Desktop Computers w/ Windows and MS Office	5	689.00			$ 3,445.00	
				Net	$ 3,445.00	
Curriculum Module Supplies					$ -	
Item	**Quantity**	**Rate**			**Total**	
Spectrophotometer--Beckman Coulter	5	8029.95			$ 40,149.75	
BK Precision Power Supply	5	829.00			$ 4,145.00	
Filters--White (100/pack)	5	1.66			$ 8.30	
Filters--Brown (100/pack)	5	4.29			$ 21.45	
AND gates (Quad Input)	20	1.58			$ 31.60	
OR gates (Quad Input)	20	0.31			$ 6.20	
NAND gates (Quad Input)	20	1.58			$ 31.60	
NOR gates (Quad Input)	20	3.49			$ 69.80	
XOR gates (Quad Input)	20	2.92			$ 58.40	
NOT gates (Hex Inverters)	20	1.59			$ 31.80	
Solderless breadboards	10	4.00			$ 40.00	
Wire (1000')	1	76.73			$ 76.73	
Wire Strippers	5	6.99			$ 34.95	
				Net	$ 44,705.58	
Materials for Science Fair Posters						
Item	**Quantity**	**Rate**			**Total**	
Posterboards--trifold (Superior Display Boards) (box of 18)	3	3.79			$ 11.37	
Construction Paper--varied colors (50 sheets)	10	1.39			$ 13.90	
Scissors	5	7.99			$ 39.95	
Sharpie Markers--varied colors (pack of 12)	2	10.29			$ 20.58	
Crayola Markers--varied colors (pack of 12)	2	7.02			$ 14.04	
					$ -	
					$ -	
					$ -	
					$ -	
					$ -	
					$ -	
					$ -	
					$ -	
				Net	$ 99.84	
Miscellaneous						
Extra Supplies, Materials etc.					$6,000	
Total Budgeted Amount	$ 93,170.42					

C. Organization of Leadership



D. Curriculum Modules

1. Rate of Filtration Lab Module

- Based on the flow lab article sent to us by Professor Meyer, a good module for us may be based off the "Rate of Filtration" exercise in our Science Fair Projects website.
- We could provide the students with a reasonable selection of filter types of various thicknesses.
- The procedure is open-ended enough for the students to make some selections
    - How many different filters to use?
    - How much water to use (what is a reasonable amount)?
    - How many trials are sufficient?
    - Is it the same for other liquids?
- The exercise also gives a good primer into Excel and regression analysis and mathematical modeling.
- The students can be grouped for this exercise, giving them a good opportunity to work together.
- If multiple groups can be formed, data sharing will also offer a unique opportunity.

Problem: Perhaps not an attention-getter, more of a tool to help students with the process of scientific investigation, rather than an actual process

2. Logic Circuits

The goal of this activity will be for students to understand the fundamentals of Boolean algebra and logic circuits. In the end, the students will be able to use frequently-used chips to implement simple algorithms or build simple electronic devices.

The materials will be needed are powered protoboards (with frequency generator, logic switches and logic indicators), electronic components (wires), digital chips and oscilloscopes. The chips needed are AND, OR, NAND, NOR, XOR, and NOT gates, D-type flip-flops, JK flip-

flops, counters, timers, numeric displays, multiplexers and RAMs. Since no high frequency applications are necessary, the oscilloscopes can be PC based oscilloscopes (*signal buffers with software, which costs only a few hundred dollars*).

To start each lab, the instructor will deliver a short lecture on Boolean algebra, and introduce the digital chips functionally. Then the instructor may demonstrate using a combination of logic gates and counters to generate a certain waveform, or showing how to use flip-flop to store bits of data. Then the students will split into groups of 3-4 to discuss and come up with a function they want to achieve with the materials. The instructor will go though the students' idea and tell if it is within the capacity of the lab; otherwise the instructor may suggest a similar but feasible function for the students to work on.

Some hints/clues for struggling students

- Make sure the students are not burning themselves or the chips.
- Timely help them review/learn R/C circuits, since the students may need them for a timer or so.
- Help the students test their projects using the oscilloscope

3. UV-Vis Spectrophotometry

The goal of this activity will be for students to discover a relationship between the concentration of a solution and its absorbance/transmittance of light.

All matter absorbs some percentage of light. The difficult part is finding what range of energies the matter will absorb. High energies of light will pass through some materials, like any aqueous solution, but will be absorbed by other materials, like metals. The Beer-Lambert Law states that the absorbance of a solution is proportional to its concentration

$$A = \varepsilon C l$$

A is absorbance, ε is the molar extinction coefficient, C is the concentration (mg/ml), and l is the distance the light must travel. The information received from UV-VIS spectrophotometry is the relative concentration solutions as well as possibly its macromolecular structure. Proteins absorb different wavelengths of light than do organic carbon structures or electrolyte solutions.

To start the lab, the instructor will present samples of a certain chemical solution (NaCl) and explain the use of the spectrophotometer. The optimal wavelength for NaCl light absorbance is 310 nm. The instructor will ask the students to split into groups of 4-5 to find a relationship between the absorbance and the concentration of the solution. The students will have to prepare solutions of varying concentrations, set up the spectrophotometer, and perform the experiment.

Some hints/clues for struggling students:

- Take care in loading the cuvettes. Smudges from your hands may effect the readings
- The spectrophotometer cannot measure absorbances over 3.0.
- Are the dimensions of the cuvette the same for all your tests? Would this matter?
- Are your solutions concentrations mg/ml?
- Try using a baseline solution (water) in slot one
- Use MS Excel to analyze your data? Make a data plot and perform some regressions on it.

If students derive the relationship, give them mystery solutions and ask them to find the concentrations based on their data. Other extensions could be to test different light wavelengths to see if the results change.