Part VI: A Bridge to the University

Mentoring High School Students in Biological and Biomedical Research

Ian van Tets (Biological Sciences and Program Director of STEP UP: WWAMI Biomedical Sciences)

The supervision of high school research projects has been a major element of my workload in recent years as a result of my involvement in the NIH NIDDK summer research apprentice program (now renamed STEP UP – Short Term Education Program for Under-represented Persons). Every summer from 2004 onwards, I have mentored at least one high school student in my laboratory through this program. These students have been very successful and the experience has been rewarding. The students have won a range of prizes at the program's national conference; their projects have been published as short reports in a supplement to a peer-reviewed journal (Appendix 1) and have provided material that has enabled me to develop and successfully obtain funding for new research foci. However, the supervision of these students has also required more from me as a mentor than the supervision of undergraduate and graduate students.

Based on my experiences with STEP UP students, I have come to believe that five factors are essential for the success of a high school student (or inexperienced undergraduate) research project. These are that:

i) the student must be strongly self-motivated

ii) the student must feel part of a team

iii) the project must be well-planned

iv) the student must have clear and achievable goals

v) the student must receive regular, clear and frequent feedback from the mentor.

Self-motivation is of fundamental importance. The successful mentoring of even the most enthusiastic of high school students requires time and effort. If the student is uninterested in research, this commitment will dramatically increase, and the likelihood of any significant benefit to either the student or the scientist coming from the research project will dramatically decrease. I do not recommend agreeing to mentor a high school student who does not have a strong personal interest in the success of the project. Fortunately, the STEP UP high school students are selected through a rigorous and competitive system that requires them to demonstrate both academic ability and interest in either medicine or medical research and there are considerable benefits associated with successful completion (publication,

travel, scholarships, NIH internship opportunities). Self-motivation is rarely a problem for these students.

Ensuring that the student *feels part of a team* is a task that the mentor should plan from the beginning of any high school project. Young and inexperienced students who feel that they are working in isolation are likely to become disillusioned and lose motivation quickly. In such a situation, instead of training a new scientist through research we are more likely to turn them away. On the other hand, young students who feel part of an active and enthusiastic team are likely to respond very positively indeed. In an active lab with undergraduate students, graduate students, post-doctoral fellows, etc. working collectively with one or more professors, this can be achieved relatively easily. In the smaller laboratories typical of UAA, it requires more work on the mentor's part but is still both practical and desirable.

Mentors can take on two high school students, one junior and one senior, or a high school student and an undergraduate student, and have them work simultaneously and cooperatively on related papers. Mentors with a solo student can, and should, make an extra effort to work closely with that student, so that the student has a real sense of working together with someone else on something that is of value. Regardless of the laboratory size and structure, mentors should do their best to ensure that the student has a clear picture of the context of their project with respect to past and planned future projects in the laboratory, so that the student can grasp and appreciate the importance of their work as part of a wider project of broad scientific value.

Planning is essential to the success of any research project. As high school students tend to have limited time, working through the basic experimental design ahead of time can be vital. It enables the mentor to ensure that necessary supplies and equipment will be available and that a clear and detailed time line can be established for the student early in the project. Waiting four weeks for a reagent is a disaster for a six-week project!

Establishing an expected time line before the student arrives greatly enhances the chances of success in short projects. My usual approach is to take the start and the completion dates for the project and to use this to calculate the time available for experimental design, for practical research, for analysis of results and for presentation preparation. From this, the dates by which each of these stages must be complete can be determined. Thus the practicality of successfully completing the project within the given time frame and the time commitment that will be required of the student and the mentor during the project to bring it to a successful conclusion. With such a time line in hand, a motivated student can usually quickly and efficiently work with the mentor to come up with a mutually acceptable and achievable protocol.

The planning and the development of a time line also helps the student and mentor to develop and establish clear goals. Students at all levels, from high school to PhD, do not intuitively see a deadline that is six or eight or ten weeks away as urgent, even if, in order to achieve such a deadline, their mentor knows and stresses that they are going to have to work in an exceptionally fast and focused manner. For high school students, one solution to this is the setting of clear daily tasks coupled with progressive achievable deadlines. For example, "Today I'd like you to complete the assays that we worked on yesterday and then, once that is finished, I'd like you to continue the background research that you have been doing in the library. We'll go through the results of the assays together first thing tomorrow morning and, assuming that we do not have to redo any of the assays, I'd like to see this part of the project completely finished by the end of the week. I'd also like you to send me the first draft of the introduction and methods section for your final report on Friday, so that we can discuss it first thing Monday morning." For a six- or eight-week summer project, every week should have at least one deadline.

Finally, and most importantly, the student must receive *regular, clear and frequent feedback* from the mentor. High school students who do not interact with and receive feedback from their mentors on a regular and frequent basis can rapidly lose motivation and drift unproductively – a potentially disastrous loss of time in a short project!

In the early stages of the project, high school students benefit enormously from time with their mentor discussing the background and rational for the research they are doing with their mentor. This quickly and efficiently helps them gain the background they need to appreciate the significance of their research and to conduct and present it appropriately. Such discussions should also include collaborative work fine-tuning the experimental design and timeline. The students will need explicit training and instruction in even the most basic of safety and emergency procedures as, unlike other research students, they typically have no experience of working in a university laboratory. The students will certainly benefit from any time the mentor can take to familiarize them with the lab as a whole: its resources, its personnel, and its practices. They will also need hands-on demonstrations of the techniques they are going to use and direct supervision, at least, the first time they use such techniques. The time commitment associated with the early stages of a high school research project is not trivial!

In the middle stages of the project, the mentor's involvement may decrease but, if the project is not to drift, the mentor should still be meeting with the student on a regular basis, ensuring that deadlines are being met, that concepts are clearly understood, that analysis and writing tasks are taking place concurrently with practical work, and that practical work continues to be done in a safe and appropriate manner.

The latter stages again tend to be busy ones, as the students typically have little or no experience with data analysis, project presentation or report writing and have equally little appreciation for the time such activities take. However, a mentor who is interacting regularly with the student, who has set clear deadlines, is receiving and reviewing data and drafts and providing feedback on presentations as they develop and are rehearsed, is likely to be pleasantly surprised. Motivated and talented high school students tend to have good work habits and respond very well to such feedback, often producing a high quality product in a surprisingly short period of time.

My experiences with high school students have been very positive and I am very grateful to the WWAMI biomedical program and the NIH NIDDK STEP UP program to work with them. The students have been self-motivated and have required conscious effort on my behalf to help them feel part of a team, to plan their projects, to establish goals and to provide them with constant feedback. They have, however, rewarded me for doing so with completed projects, novel insights, excellent research presentations, published reports and material that has enabled me to develop and fund new research focus. Mentoring is not a trivial commitment but it is one that I recommend to those who have the time and the opportunity to do so. The STEP UP program is always looking for more mentors.

Appendix: Selected Examples of Research Products generated by high school student projects mentored by the author.

(NIH NIDDK STEP UP program, UAA WWAMI Department of Biomedical Sciences, 2004 – 2007). A single asterisk (*) denotes students from Alaska Native backgrounds. Double asterisks (**) denote students from other minority backgrounds.

Awards (total of 5 granted from 2004-2007)

Aparicio** J. 2007. Excellent research (senior, oral presentation) NIH National Institute of Diabetes and Digestive and Kidney Diseases. Student research conference. Washington D.C. USA.

Infante* S. 2007. Honorable mention for research (junior, oral presentation) NIH National Institute of Diabetes and Digestive and Kidney Diseases. Student research conference. Washington D.C. USA.

Publications (total of 9 from 2004-2008)

Chon**, D.Y., Stevenson, K.T. and van Tets, I.G. in press. Seasonal changes in bone mineral density in the northern red-backed vole: A potential model organism for disuse osteoporosis. Accepted for publication in *Ethnicity and Disease* (scheduled for publication in 2008).

Lim** F-F and van Tets I.G. in press. Do rats that Frequently Drink Alcohol Deposit Fats in a Way that Increases Their Risk of Type II Diabetes? Accepted for publication in Ethnicity and Disease. (scheduled for publication in 2007).

Nay* L., Stevenson, K. and van Tets I.G. in press. Seasonal Changes in the Reproductive Organs and Body Condition of Northern Redbacked Voles (Clethrionomys rutilus). Accepted for publication in Ethnicity and Disease. (scheduled for publication in Dec 2007).

Conference Presentations (total of 19 from 2004-2007)

Lindner* S. and van Tets, I.G. 2005. Using Dual-Energy X-ray Absorptiometry to measure the effects of alcohol on the composition of rats' livers, hearts & kidneys. National Institute of Diabetes and Digestive and Kidney Diseases. Student research conference. Washington D.C. USA.

Nay* L., Brennan A. and van Tets, I.G. 2005. Intestinal morphology of Northern Red-Backed Voles on two different photoperiods. National Institute of Diabetes and Digestive and Kidney Diseases. Student research conference. Washington D.C. USA.

Stevenson, K.T., van Tets I.G., Chon** D.Y., Mayfield, J.D., and Barnes, B.M. 2007. Seasonal changes in the bone mineral density of a non-hibernating Arctic rodent species: The northern redbacked voles, Clethrionomys rutilus. 29th Annual Meeting. American Society for Bone Mineral Research. Honolulu, Hawaii USA.

Nay* L., Stevenson, K.T. and van Tets I.G. 2006. Seasonal Changes in the Reproductive Organs and Body Condition of Northern Redbacked Voles *(Clethrionomys rutilus)* American Association for the Advancement of Science (Arctic Division) Annual Conference, Fairbanks, AK.

Mentoring Rural Students

Don J. Rearden (Preparatory and Developmental Studies)

This perspective frames a context for a successful active learning environment for at-risk rural Alaskan students.

During my undergraduate days at UAF, my friends and I coined a new term for our rural peers who attended school for one semester and then went home. We suggested those one semester scholars were "taking a break" from the rigors of academic life, the changes in diet, and culture. As rural students ourselves, both Native and non-Native, we sought out those who shared similar experiences and created our own sort of village away from home. Still, not many of us made it through to graduation. Most surrendered to the call to "take a break" and never returned. The few of us who survived the undergraduate years had one thing in common: we all had faculty mentors.

Now, as a faculty member myself, I try to do all that I can to reach out to my rural students in an attempt to ease their transition to urban life, provide academic guidance, and most importantly, establish myself as a person they can turn to in times of need. Having grown up in Southwestern Alaska, I feel I understand the daunting challenges our students face, because I have faced and continue to face many of those same challenges.

But what about those faculty who aren't familiar with rural Alaskan life or the students who come from across Alaska to attend our institution? How does a faculty member establish a mentoring relationship with a rural student?

Faculty mentor Don Rearden (right) with an undergraduate student.

Challenges Rural Students Face

The first step in understanding how to best approach mentoring rural students is to understand the complexity and diversity of challenges the students encounter when moving from home. The average American freshman endures a multitude of issues that first year in college, and rural Alaskan students face those same difficulties and more because they are often coming from isolated, remote communities.

Imagine living on a floor in a residence hall with sixty other students, roughly the same number of people who live in your home village, or consider the