Statement on mentoring philosophy and practices

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I joined the University of Pittsburgh as a tenure-track assistant professor in 2003 and started to mentor my first PhD student in 2005. In 2008, I established a virtual laboratory, named "Bioinformatics and Statistical Learning Lab", by constantly advising and financially supporting 6-10 PhD students at any given year. I have graduated 20 PhD students in Biostatistics or Computational Biology between 2008-2018 and have another 7 students on-going. Throughout my research career, I have believed that training the next-generation statistical scholars and genomic scientists is a vital part of my academic mission and vision. In contrast to recruiting post-doctoral fellows, training PhD students on their research capability, skills and habits can consume extra time and energy at the beginning. But their capacity, creativity and alternative perspectives will be developed and later bring positive feedback to our research program. After they graduate and bring impact to academia, industry or government, they will well represent our University and my research group and this will in turn attract top PhD applicants to our University in the future. Such a virtuous cycle is particularly true for the rapidly growing biostatistics and data science field where a single principal investigator can never succeed without motivated and innovative graduate students. Below I outline four aspects of my mentoring philosophy and practices, which I have learned and gradually adapted in the past decade.

Encouragement, motivation and vision throughout PhD training

In contrast to undergraduate or master students, I believe learning independent thinking and ability of self-learning is the top priority of PhD training. For many junior PhD students, I have observed a stumbling period when students are used to classroom setting and wishes to receive detailed instructions to follow in research. In this case, I would pay extra attention in weekly individual meeting to guide their research logic and encourage them to independently explore literature without telling them the answers or next-steps upfront. At this stage, students experience radical changes to establish their own research reasoning, perspectives and habits. Patience, respect and inspiration from the advisor is critical. The process can sometimes slow down the research progress but it best motivates students and helps them enjoy research. In my mind, PhD students are not employees to accomplish my projects as a "programmer" but instead they should enjoy ownership of their projects as a "researcher".

Once a student is motivated, I also train students to build their own research taste/viewpoints and vision of their future career. As PhD students tend to only focus on a small area related to their thesis, reminding the global picture is advisor's constant duty. I believe that encouragement, motivation and vision are the three key elements in PhD student mentoring so that they learn to embrace challenges, overcome research obstacles and become filled with passion and joy in research.

Positive and supportive lab culture

Since I started PhD student mentoring, I have made extensive efforts to gradually establish a positive culture in my research group, with high standard while being supportive and encouraging. In my discipline of Biostatistics, PhD students normally spend two years on course work, subsequently take qualifying exams and then select thesis advisor at the beginning of the third year. In 2008, I made an unusual decision to recruit PhD students to my research group from their first year. The approach brings high funding burden to my lab but comes with tremendous benefit for PhD student training. With early start on research, I can spot their weaknesses and provide necessary guidance in early years. As statistical papers in high-profile journals normally take longer time (1.5-2 years) to publish, paper submission in early years help strengthen students' CV at job hunting. Students have longer time to gain research maturity, develop quality thesis and more likely to win student paper competitions, all leading to a positive impact towards successful job hunting. In 2012-2018, I have graduated 12 PhD students and seven of them have obtained faculty positions. Many of them have won student paper awards and travel fellowship to conferences. Of the 88 papers I published in these years, 81 of them were co-authored with my PhD students (see CV and student list).

In the research group, I try to create a vibrant and friendly interaction environment to brainstorm new research ideas. I form working groups dynamically for junior students to work with senior students. Through the collaboration, junior students can learn numerous research skills and hands-on techniques from senior students, which may be difficult to obtain from advisor or other faculty. For example, as a principal investigator, I have not written serious programming code for more than ten years and students often learn modern programming techniques from their peer students more efficiently. Through the interactions, junior students also observe role models and successful examples and feel motivated to improve and achieve. On the other hand, when senior students mentor junior students, they become more engaged and mature, and would be better prepared to be a good advisor when they later become a faculty. With the constant efforts over the years, I have experienced a dramatic change of research atmosphere in my lab, which is evidenced by increased motivation and innovation from the students, their dedication to top-quality research, and their willingness to advance to competitive academic career.

In the past decade, I have recruited PhD students mostly from Eastern Asia, such as China, South Korea and Taiwan, due to many high-quality applicants from these regions. I have noticed the importance of diversity and have increased recruitment from places such as the United States and Bangladesh.

<u>Personalized mentoring and training</u>

Through mentoring relatively large number of PhD students in the past years, I have gradually learned to appreciate diversity of students' personality and talents, and to develop each student in a personalized manner. Since I recruit PhD students into my lab early, I pay attention to identify their deficiencies at early stage and provide opportunities to develop them. For example, some students have high potential but are timid to express themselves or to try new ideas. I would remember to praise them when they achieve, ask for their opinions in group meetings and encourage them to think outside the box. For some other students with unrealistically high expectation but are still not solid on some

research foundations, I would slow them down and work with them on fundamental concepts, formulation or statistical inference before moving towards sophisticated modeling. For many international students, writing, oral communication or presentation skills are often their weaknesses. I would assign them more presentations, arrange suitable collaboration opportunities with other labs or give them more guidance in paper writing without taking over the writing too early.

For career development mentoring, I remind students to plan early and to learn their own strengths and weaknesses through research process. In some extreme cases, I have observed students with strong academic quality (creative, bored to do routine things, wanting freedom at work, etc.) but expressed intention to go to industry. Reversely, I have also observed students with quality suitable for industry jobs (e.g. enjoy routine jobs and lack of research innovation) but wanted to find postdoctoral jobs towards a faculty position. For both cases, I would first respect their preferences but patiently explain pros and cons of academic versus industry jobs through an open-minded conversation. In the end, I would encourage them not to rush for decisions but keep in mind to constantly explore while they work on PhD. I also encourage them to take summer internship in early years or attend career workshops to gain more information. Eventually, I would pray for them but respect them as an adult to make their own decision. In most cases, I have seen their ability to make wise decisions when they graduate and joyfully go to the next positions. As a father of five children, I constantly remind students that research is not a sprint but a marathon, and encourage them to consider family needs and seek a balanced life while they make career decisions.

When a student expresses strong interests towards academic career, I pay extra attention to help them develop a competitive CV. In addition to methodological and collaborative papers, I find them suitable teaching opportunities and include them in grant writing preparation. I also refer them to apply for travel fellowship for conferences or workshops and to submit manuscripts for student paper competition. For students interested in government or industry jobs, I pay attention to develop their presentation and collaboration skills. I would introduce them to suitable talks or job fairs in conferences and connect them to our department alumni in industry or government.

<u>Mentoring after graduation</u>
I consider my relationship with advisees life-long. I maintain periodic connection with almost all alumni via emails, phone calls, reunion in conferences and even sending Christmas cards to each other. For students holding faculty positions, I provide them advises such as on how to balance in research, teaching and collaboration, how to write grants and how to work effectively towards tenure. In some situations, I also refer them opportunities to organize sessions in conferences, review papers for top journals or establish new collaborations. Seeing a PhD student to become an independent investigator is always a fulfilling experience, which I always imagine would be like seeing my children to move out and go to college.