My Guiding Philosophy for Advising or Mentoring a Robotics Team

Draft VIII
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Introduction:

The following is an outline of the philosophy I've developed over my time spent in educational robotics programs.

I've written and am sharing this document for two main reasons: The first is that I would like to share my philosophy of the role our robotics program as a part of a holistic educational experience. The second is that I would also like to share my philosophy of my role as a teacher and mentor.

My Background

I think is it important, before I begin to explain my philosophy, to explain how I got to this point, and what my experiences in the world of educational robotics competitions have been.

I am 25 years old. My background in robotics goes back to the year 2000, when I joined my high school's FIRST robotics team, as a freshman, at the urging of my science teacher, Paul Kloberg. When I was growing up, I was the kid on the playground reading a book. I was no athlete and didn't really have a place to fit in with classmates. Robotics gave me a place where I could challenge myself, intellectually, and do something as a part of a team after school. That first year, I became the lead strategist and tactician for the team. I created and executed a plan for creating databases of robot abilities, with accurate information from the field. This was vital to that year's game, as 4 robots all had to work together for one task, and the faster that task was completed, the higher the score. If teams could be more efficient, their collective scores would rise.

I did this mostly on my own, and saw success as the result of my ideas put into praxis. At that point in my life, I had never been prouder of something than that project. It was, challenging, and satisfying work that gave me a feeling of achievement. I wasn't just another student in the classroom. I found a sense of competence, a sense of achievement, and a sense of being a part of a community and team.

I continued with robotics up through high school, then worked as a volunteer during college, and also helped to set up events in the northeastern United States. In my junior year of college, I got involved with Vex, (Then a part of FIRST called FIRST Vex Challenge, or FVC), helping to set up events along the east coast, including the NJ championships at The College of New Jersey (my undergraduate college), and ended up as a key volunteer at the early World Championships. It was there that I met the team that I am currently the faculty advisor for. My senior year of college, as a student-teacher, I served as a faculty advisor for a FIRST robotics team in a school near my college.

By chance and circumstance, my first job interview was at West Morris Mendham High school – home of Team 3053, Occam's Engineers, Inspire Award winner and Winning Alliance captain in the 2007 FVC competition at their World Championship event. Over the past three years, we have gone from one small team working mainly outside of school, to about twenty five students arranged in five competitive Vex Robotics Competition (VRC) teams and a SpecOps group that works for the organization as a whole. Three to four days a week, after school, we fill our school's technology lab to capacity. Students often take robots and parts home to work during weekends and breaks.

I also help to run and set up VRC events in New Jersey, along with other repeat volunteers such as Paul Kloberg and Mike Snook. We've gotten pretty good at packing and unpacking VRC competition fields, AV equipment, and game elements, all the while maintaining a reasonable degree of sanity.

So in summary, over the last eleven years, I have served as a student, as an outside volunteer, as event coordinator, and as a faculty advisor for two separate, and very different educational robotics programs. I feel that I have seen a good cross-section of what works, what doesn't work, and seen the effects of different barometers for success and different definitions for the "right" spirit of competition from many perspectives throughout my participation.

Philosophy: What is Robotics?

Ultimately and perhaps paradoxically, I believe that the heart of an educational robotics program isn't primarily about robots. It is about creating a place for students to feel safe, accepted, and connected. It is about giving students the freedom to explore and experiment, and learn through the process. At its core, I am not the advisor of a "club" as I am of a supplementary educational program. It is a different kind of educational program; most classes are highly structured – they have to be. As a teacher, there is curriculum to follow, standardized tests, AP tests, IB exams, national standards, school standards, and state standards that all need to be followed through the year. An after school robotics program doesn't have those constraints, so students can explore their interests as their journey takes them. They have the freedom to take risks, to sometimes fail, and to learn from those experiences. It is learning by exploration, rather than by dictation.

By allowing students to explore and discover things on their own, with measured and minimal guidance from me, I feel they learn a lot more, not just in content, but far more importantly they internalize the process of thinking critically and creatively. Perhaps, if things go right, and some inspiration is sparked, they may rediscover a sense of discovery and pleasure in education. There is a significant cognitive different in exploring knowledge versus learning a set curriculum. Learning the "right answers" isn't education. Education is about asking the "right questions." Being about to think independently, creatively and critically view a problem, and then seek out and pursue avenues of inquiry that lead to greater understanding – that is what I feel the purpose of real and valuable education is, and that the purpose and value in this robotics program. We don't build robots in order to compete; we compete in order to build robots. It is a means to an end: an educational tool.

The Role of the Advisor:

I feel that measured and minimal adult intervention is important for developing a culture of ownership within the team. When students are in control of the process, including idea development, building, programming, and taking initiative on awards and interactions with the public, they learn leadership and personal responsibility skills that have a positive impact on the program. Their enthusiasm and energy compounds on itself, and can be self-sustaining.

I believe this can only be done in a healthy, sustainable way by having students taking initiative in having control of the process. This is the way I found my place in robotics when I was a student, and the reason I was eager to be the advisor of an extracurricular robotics program; I could give students the same opportunities and experiences that had such an impact on shaping who I became as an adult.

From my experiences, I've seen the pitfalls of heavy leadership and involvement of adults firsthand. Students are conditioned to accept adults as their leaders. In the average classroom, the teacher has the answers, and students are trained to respond to the instructor's questions with the "right answer."

With my robotics teams, I generally respond to student questions with questions of my own. For example, my response to a student inquiry of: "Why doesn't this work?" would be "Why do you think it doesn't work?" After the students expresses his or her theory: I ask, what could you do to test that, if that test is negative, what else could be causing the problem?"

In the entire exchange, I give no information, or very minimal information; I simply ask students what they know. Most of the time, students know what to do, and they have all the information they need to solve the problem. When they ask a question, they want affirmation: they just want to hear it from an authority figure. By denying them that safety net, students are empowered to take initiative, take risks, and learn from failures or setbacks. Eventually, they stop asking questions of the instructor, and learn instead to share information amongst each other and truly troubleshoot their problems in a way that is logical and self-directed. After a while, they become very eager to test a hypothesis, try out a new design, or work out a new strategy: they have gained the confidence to take risks, and have confidence in themselves to know that they have a scaffold of knowledge, experience, and support to allow and encourage them to reach higher.

It is not uncommon for my students to redesign and rebuild the robot constantly – even after winning or being successful at competitions. The process of recursive improvement for the sake of building a better design is internalized when students take pride in the process, and a part of that pride is being responsible for the success of the design by working out the bugs, glitches, and challenges that arise throughout the design process.

The emphasis on the process also deemphasizes the role of the competition as the main goal for the activity. The competition becomes a proving ground for the design – the design work is what is important – the competition is merely a place to test the design and see other ideas and solutions to the same design problems. By focusing on the process, I believe robotics becomes a highly educational activity in terms of both character development and of serving as a platform for engineering and design curricula. Lessons in mechanical engineering, design, and programming are self-directed and internalized. Because the design process is by nature both recursive and holistic, not only are students learning discrete concepts but are also learn how they interrelate, and to apply them in concert.

Maintaining a Values Driven Approach

I have five core values that encompass the overarching ethos of how I advise my robotics teams. All five are interconnected: the loss of any one affects all others, creating an unstable system. They can be described as the following:

1. Ownership
2. Productivity
3. Sustainability
4. Unity of Vision
5. Sanctuary

1. Ownership

I passionately believe that developing an environment in which students direct and "own" the design and learning process is vital for unlocking the potential of robotics as a tool for learning. Many students are a part of an education system that is quite micromanaged and structured. There is a lot of pressure to the get "correct" answer, and information is indiscriminate and disparate between subjects. Rarely are curricula integrated in a way that is meaningful – my leadership style allows and encourages students to work to realize avant-garde ideas and take risks without fear of failure. If it fails and something is learned, the experience was valuable and thus not a failure.

This "sandbox" approach seems to be particularly attractive to gifted students because robotics is so multifaceted – there is the strategy of the game, mechanical design, and programming, working with random partners, playing random opposition, and navigating human interactions. There is a lot of "mind food" available to challenge students intellectually in the form of a game, and giving students the freedom to play that game without undue interference, by taking their own initiative is the basis of creating a culture of leadership where smarts and craftiness are celebrated, and mistakes are forgiven as learning experiences.

Allow students to take initiatives and feel free to experiment without a fear of failure – not only in terms of the robot, but also with everything else. It is important that the program is truly student-led in order for it to stay student-oriented. I've found that students become passionate about the program, and by investing in it, they "get" more out of the experience. Let this culture develop itself, and it will become self-sustaining by its own nature.

I like to call the environment "constructive chaos" – ideas flow freely, experiments are performed, and learning happens. This is different from lawlessness – students need to be on task, but are free within their task. The analogy of the sandbox again works well here – as long as students are in the sandbox, (that is, on task) – then they will learn and grow within that sandbox.

2. Productivity

Each student needs to be productive and have a role in the team. Some are inclined to be programmers; others are more interested in mechanical aspects. Still others have little interest in building the actual robot, but work on press releases and media relations, artwork, and aspects of the program that are not technical.

To build an organization, and not just a team, you need students that can look at the big picture and belong on every team and no team. I called my group of students "SpecOps" which stands for "Special Operations." They write essays, take pictures at events, write press releases, make banners, signs, logos, buttons, and help with other projects, along with students attached to specific robots. They help where needed and fill in any gaps in the organization so it can function smoothly.

The idea here is that everyone needs to fulfill a role. This minimizes distractions, builds unity, and ensures that everyone is working together on the "big picture" project: running a robotics team – combination engineering competition and small business.

The idea that every member needs to contribute (no dead weight or freeloaders) also extends to what certain people do *not* do. Adults generally are not involved besides assisting in supervising fundraisers. As advisor, I do the administrative things that students cannot do, while leaving the rest up to them. At the start of the year I give each team an engineering notebook. I arrange students into five teams, with between three and five students per team. After that, students self-organize within their teams. They come up with their own designs, strategies, and ideas. I do not touch parts or contribute to their robots – that is the job of the students.

Students form a solid foundation for future learning and cultivate a body of knowledge by exploring the problems basics and building complexity. In my experiences as an advisor, students who control the design process develop exponentially complex and successful designs in a relatively short period of time because their knowledge is based on a visceral, tangible foundation of past mistakes and lessons learned.

An environment of ordered chaos allows a lot of great things to happen by circumstance, by design, or by accident – and the combination is the best way to nurture students to take control of that chaos and turn it into something of their own design that they can be proud of. There can be little personal pride to be had by just following the orders of an authority figure. I am the advisor, not the leader. Students are internally motivated to be productive by genuine interest, rather than top-down enforcement.

3. Sustainability

Being financially independent through student-led fundraising shows the community that the students are dedicated enough, and believe enough in something, to work for it. It teaches important life skills, such as planning finances ahead and forming a budget. Fundraising cultivates entrepreneurial spirit, and builds camaraderie amongst students.

While measured, appropriate adult support is s key part of successful fundraising; I feel that student leadership in this is the best way to go about building those skills, along with a culture of self-reliance and a sustainable program model. This has to be ground-up, not top-down. One of the main issues that have continued to disturb me with regards to fundraising in educational robotics culture is an emphasis on corporate sponsors or donations. The problem I have with that model is that it is a top-down system, where teams become dependent on outside sources of revenue to sustain their program. I have also been privy to a number of teams who corporate benefactors leverage control over aspects of the team for their own gain, rather the benefit of students.

When I came to be the faculty advisor of VRC team 3053 (and subsequently expanded to include 3054, 3055, 3056, and 3057) I've worked to emphasize the importance of fundraising to students, and have them take leadership and ownership of fundraising. We have held bake sales, worked on a farm, built and sold birdhouses, and we have sold HexBugs. Again, this goes back to owning the process. At the end of the process, students worked for every bolt on their robot, and every registration fee. It teaches students personal responsibility, and it teaches students to respect the value of money.

When students come up with a design that requires the purchasing of a new part, they must weigh the benefit of that part with the labor that goes into purchasing it. Rather than thinking in terms of "this is a 100 dollar purchase" – they instead think in terms of "This would cost 10% of our fall bake sale, or we can work on a farm for ten hours." It changes the way students think of money, and adds a price constraint to designs.

Business and personal donations are fundraising sources that should be measured and constrained – students should have to perform some work to earn those funds, be it a board presentation, or writing a grant. Both are useful skills. Be wary of any fundraising activity or donation that does not involve a learning process – building and selling birdhouses, putting together a business model in order to make a sales pitch to a company, writing a grant, or working on a farm are all activities that build character and work to enhance the educative value of the program.

Self-directed, grassroots fundraising also teaches students to be responsible and be a productive member of the workforce. Particularly in this economy, students need to learn to take pride in labor and productivity, rather than depend on handouts for survival. I do not accept corporate donations or school funds, and I favor activities where students are actively building or creating something for a profit, or otherwise performing a service. It is important that students have the pride of working hard to achieve a goal, in addition to the work of building the robot. It goes back, again, to investment – if students are proud of what they do, and are engaged in the process, they will better internalize the values the educational program implicitly teaches.

It is also important to be intellectually sustainable – engineering notebooks are a good way for students to pass on a body of knowledge, which optimally grows each year, as students collectively build on previous experience and knowledge.

If a team or organization is not sustainable, they will run out of money, personnel, or interest and collapse without external assistance. Thusly, teams that are kept in being by outside funding, contrived interest, or external incentives are not sustainable. In fact they are highly unstable – there is no intrinsic motivation on the part of the prime participants in keeping the organization together to rebound or adapt from trauma, administrative changes, or alterations in format or setting.

A team needs to be driven by student interest, and student leadership helps to generate that interest by shaping the culture and direction of the team or organization. It is about students investing themselves personally in the project. In short, they need to care.

4. Unity of Vision

The most important thing the club advisor can do is set expectations of behavior and values that students will follow. If there is a disparity between expectations, goals, or core values, then the result will be an unhealthy organization. This disparity can occur with students, parents, or any other entities with the advisor or mentor of the robotics organization.

In my own organization, I try to attract students that are independent, respectful, and generally nice to one another and to others. This is because I set expectations of that conduct. Students that do not have those traits generally leave through attrition.

I've had personal experience, as a student and as an advisor, dealing with students that have caused problems due to immaturity, personality, or lack of responsibility. Robotics is something that takes up a lot of time and energy for certain dedicated students, and when students own the process, there is a lot of personal pride at stake in outcomes – if the students happen to win an award, and there are students that did not contribute to it sharing the credit, it is disheartening. The "no deadweight" policy ensures that all students can take pride not only in their contributions, but those of the team as a whole. It is also not fair for a minority of students to detract from the experiences the rest of their teammates.

Students will also be courteous to other teams and other adults if you foster that culture. If you foster a culture of cutthroat victory as a goal, then that is what you will receive. Because I emphasize the process, my students are generally hard workers at competitions, but they realize the competition for what it is – winning is nice, but testing their design is more important. If they win or are successful, it is because they have a successful design. The process takes priority.

Setting expectations and "living your values" sets a positive role model for student behavior and what values your team emphasizes. This then becomes evident in their conduct and their self-esteem. When my kids won a tournament, and on the ride home, were discussing what they could fix and improve, and the following Monday took their robots apart, it shows that the students value the process and value self-improvement, rather than their design process with a proven formula. The thrill of entering unknown intellectual territory means more than conquering a competition.

It is important to never, (explicitly or implicitly) develop a culture of pandering to awards, of not rewarding risks and initiative, and emphasizing the competition over the design process. As adults, we have ideas on how to build a winning robot, and with a heavy hand, we can greatly "improve" the end products of our students, edit or supervise the writing of award essays, and other aspects of the competition. Along the process, we know how to avoid mistakes that students will make as they learn and acquire experience, and we can turn students back from a less-than-optimal design. It's frustrating to watch students make simple, avoidable mistakes – but students need to make mistakes in order to learn from them.

Likewise, my students coach themselves at competition. I do not offer input to alliance selection, strategy, or tactics. They advocate for themselves (but I am there if they need me, and I've never had to intervene for them). I give students the responsibility to take control, and the distance they need to exercise that control, and they thrive. At competitions, my students are autonomous – they operate without me being there. They self-organize with minimal guidance, they all have tasks, and they take pride in their design. It's all about ownership. You have values, and you live by them. You don't need a slogan about acting professional or gracious – you exemplify it without language. You live what you value. A way to do this is to be objective and always think of the long-term consequences. If you consistently plan for the short term, you will have an erratic, inconsistent long term. When a culture has chaotic or conflicting values, it will not be a peaceful, positive culture. It will have turmoil. While the creative, educative process needs constructive chaos that is guided to an end goal, and governed by values, turmoil and conflict poisons it.

5. Sanctuary

One of the most important and emotional moments of my entire career was when a student came up to me and told me that she enjoying coming to robotics because it was a place she felt safe to be herself. When students are free to learn from mistakes and feel protected and safe with one another as well as their environment, the education process flourishes. I believe that robotics can be an excellent program for students with a wide range of interests, from science and engineering to art and business. I feel that students have the most fulfilling and educational experience when they work with others as a team of equals, where everyone's strengths and interests are supported and valued.

Teams that are cutthroat, aggressive, or lack a unity of vision cannot be a sanctuary for students. A consistent ethos and philosophy that is based on respect and learning naturally forms a sanctuary for students. A good analogy is a sandbox: students are free to explore and create within the constraints of the sandbox and all their efforts flow together to a final creation. The most important thing I try to impress upon students is a sense of safety from any type of harm while in my program: students should have a relationship of mutual respect and cooperation with the advisor as well as each other.

Robotics needs to be a safe place. Strive for excitement, not stress, and passion rather than aggression. Emphasize the learning process rather than winning the competition. The process is recursive – experience, confidence, and knowledge build with each iteration. Teams that strive to become better, rather than strive to win at any cost, will be successful. Becoming better is about education – learning from experiences in a way that will change the way a team build or performs. If victory is a team's goal, then not winning implies failure. A process-driven team can only fail if they do not learn from their experiences. As human beings, we are wired to learn from experiences. It occurs naturally. It can be further promoted through the value system and culture of the robotics team or organization.

When the environment in classroom or environment in which you run your robotics program is positive, and students feel comfortable to experiment and expand their range of skills and experiences, the other four previous values can take root – fun, deep learning cannot happen in a negative, overly chaotic, or aggressive environment. A nurturing environment encourages students to explore learning and to grow and develop as people – a facet of an educational program that is far more important than learning programming or mechanical design, or any other content.

It is important for the advisor to not get carried away with competition, and always remember that the majority of the learning that happens in robotics has nothing to do with the robot – it is the relationships formed within the team, and with others outside the team, the commitment and pride of creation, and the self-actualization of the learning process that should be the core of an educational robotics program. It is important to define success by growth and learning, and create, both physically and intellectually, a culture in your program that reflects that.

Putting the Values Together

The five values I've outlined do not exist in a vacuum – they are all interwoven with one another. I feel that in order to have a truly well-rounded and meaningful educational robotics program, you must have all of these values working together, and a deficiency in any means that there is a systemic weakness in the overall program.

Ownership, Productivity, and Sustainability can be considered more tangible and physical than the latter two core values. They are an ethos for actions, and are guiding principles for "how" to go about operating as a team.

Unity of Vision and Sanctuary are more abstract, and focus on imbuing actions with meaning. If the first three values are the heart of a robotics program, than the latter two create the soul.

Personal Note and Conclusion:

In a middle/high school competition, I firmly believe in minimal adult influence. By disassociating the adults in the room with *team* leadership, students have free reign to engage themselves intellectually with a very challenging program – it gives them an outlet for their curiosity and their ideas, and to pursue interests that they do not get in a highly structured, "follow the leader" culture that surrounds them for much of the day. I guard the sanctity of that culture on my team. Without it, the program loses, at least to me, a lot of potential as an educational platform. It must be a sandbox, and not a construction site.

Some will argue that no matter what the methods, as long as students on the team are "inspired," by adults, the program is a success. I disagree. It's not enough to graduate students who have gained some experience and declare an interest in a related field. The overriding objective, to me, is to give students a program where they can go through a creative, challenging process, be proud of their work, and learn to be leaders, workers, collaborators, and independent thinkers that an operate within a relatively free and democratic system. In most formal educational activities, there exists a barrier between teachers and students. The adult is the leader; he or she is the one to be followed. There are right answers that must be "found" and then verified by the authority, and the teacher's judgments on the matter must be trusted, or accepted as a matter of course for the sake of a grade.

In a minimally (but competently) structured program, the cognitive challenges that are inherent to the complexity of an educational robotics program can be fully explored by students in accordance with to their interests. Students chart their own course – they become their own leaders in a microcosm of democratic governance. This is the true value of the program, that students can be the owners of their process and as a result, feel genuine pride and accomplish own their achievements as something personal.

For me, robotics as an activity and program is not based solely on producing a robot. It is about children realizing their own potential to become independent, capable, and confident adults. It is about changing the way students think: to be creative, collaborative problem solvers, to learn to take responsibility and become leaders, and to feel pride in producing and creating, rather than consuming or possessing. That's what education needs to be about. I think our collective future depends on this cultural shift.