General Outline & Objectives for Teaching:

Battery Technology and Application

Goals:

I would like to put forth an idea for what could be a class to teach students the "ART" of creativity and problem solving. I plan to do this around the subject of batteries. Why batteries? I want a subject that today's high school students can relate to, and in my opinion, batteries will play a huge part in how the energy struggle will happen in their lifetime, given:

1. Global Warming;
2. Limitations of fossil fuel
3. Over-population.

We need short-term solutions to a yet-to-be-found sustainable balance. I believe batteries are an answer. One important fact is that several car companies have an Electric Vehicle in prototype development that gets 300 miles on one charge, and can be recharged to 80% in 15 minutes. I think that 25% of vehicles on the road will be EV's by 2025, and that number could rise to 50% by 2030. A trained public is the major holdback in this happening. Who will keep them running and serviced? Who will know what to sell or even what to buy?

We need to start now in teaching those people. I am not sure the current educational system has the technical expertise. This is where I propose using the help of the business community and retired seniors acting in parallel with teachers.

Batteries are also an item that students use in their everyday life, charging their cell phones and tablets. In keeping with the "Art" of creativity and problem solving, I would like teach by doing using hands-on tasks and letting students solve real problems. We need to grab their interest and teach them the skills needed for finding solutions. It isn't magic, there are many ways to figure out solutions. I have three basic rules:

1. Look for simplicity and balance;
2. Look for how nature has solved similar problems
3. Keep an open mind and don't be afraid to fail.

By teaching with this approach, you just bring so much more to the table. An additional benefit of doing this is to:

1. Establish a bridge to a wider input of current technology;
2. Setup a structure for experienced retired seniors to volunteer;
3. Link the business and manufacturing need for trained workers.

To my knowledge, this structure doesn't exist in Allegan County today. I have been working for the last three years, seeking a way for seniors to volunteer in education, and have not found a way to do it in a meaningful way. I am a member of the Allegan County "Commission on Aging" and also serve on the board for the "Area Agency on Aging", and plan to bring up the topic of setting up pilot projects for Senior Volunteering at their yearly planning meetings. What I would like to do is get the backing of the educational establishment to support the value and need for this project. This backing would go a long way in bringing this dream to life.

Battery technology is a complex and rapidly developing topic, traditionally taught in a post-high school environment. I would like to start a high school class, and learn how to involve seniors and commercial interests. At this level, we could start with less complexity and learn what the process needs. The world is changing, and how we teach has to change also.

I don't have any training in teaching, and plan to work as an assistant and technical advisor with an experienced teacher. It is my personal goal to use this class as a learning tool for education, through setting up ways for retired seniors to stay involved by giving back to the younger generation their knowledge and experience. I have always had a hard time learning by reading and having a teacher tell me facts. I learn best by doing things myself. I also think collaboration is an excellent way of solving problems, and that is why the last part of the class will breakup into 3 teams and build 3 different battery packs to the same specifications, but with different types of batteries.

Computers are a major part of our lives, and it is important to help students develop computer skills, especially in how they are used in manufacturing and design. I would like to help the students who are able and willing to explore micro-computing with the Arduino UNO+ platform, using an easy-to-learn Python+ software system. The starter kits cost only $35, and all the training is done online.

Allegan County happens to have a major world leader in battery manufacturing right here in our county, namely LG Chem in Holland. We need to take advantage of that. I would like to at least have a field trip to their facility. It would also be nice to setup some corporate sponsorship relations. Finally, if we are successful, I would like to expand the program both to lower grades and to college and trade levels.

Class Description:

I think the basic class could run from a minimum of 70 to as many as 80 sessions, dependent on the level of student ability and interest. The first effort will be to make a connection with the students by getting them to perform hands on projects with kits and the safe to use of AA batteries instead of the more dangerous Lithium Batteries. After that the goal is introduce terms and theory need for future projects. Next, they would each build a USB battery pack to power their iPhones and laptops. After that, I would like to have groups design and build three larger packs with different types of batteries and compare their performance. For student with special interest and ability I would also like to introduce computer-automated testing through an optional extra 8 classes, with the results used to evaluate the projects built by the students. This would provide an insight to future classes involving batteries, computers and creative design.

Session topics:

1. **Introduction to terms and fundamentals of electricity**
   Day1 What and Why we plan to do
   Day2 Build a Copper Battery
   Day3 Test Copper Battery
   Day 4 Build Activated Carbon Battery
   Day 5 Review Week and Plan next week
2. **Battery Project I**
   Day6 Assemble and measure AA batteries
   Day7 Start Battery Kit Projects
   Day8 Continue Battery Kits
   Day9 Continue Battery Kits
   Day 10 Review Kits
3. **Basics of Batteries I**
   Day 11 History of Batteries
   Day12 Current state of use
   Day13 Future of batteries
   Day14 Battery Charge Control
   Day15 Battery Safety
4. **Basics of Terms and Theory**
   Day 16 Potential, Flow, Power, Energy, Work
   Day17 Resistance, Capacitance, DC & AC current, Fields
   Day18 Power generation and distribution
   Day19 How to measure battery performance
   Day20 Review and plan

5. **Current State of Batteries and where it is going**
   Day21Review basic battery theory
   Day22 Lifex and Lithium polymer
   Day23 Cyclical and folded configuration
   Day24 Series Parallel Design
   Day25 Energy density
6. **Plan a Project: USB power pack (each student will build a pack)**
   Day26 Review Hardware and watch DIY Video
   Day27 Review Spot Welding
   Day 28 Start Battery Assembly
   Day 29 Connect TM4056 And Step-Up Circuits
   Day 30 Connect Switch and mount in Plastic box
7. **Build USB pack I**
   Day 31 Test Voltages
   Day 32 Discharge Pack
   Day 33 Discharge Continue
   Day 34 Charge Pack
   Day 35 Charge Continue
   Day 35 Review Project
8. **Test performance of USB packs**
   Day 36 Test Stored Energy
   Day 37 Test Stored Energy Continue
   Day 36 Write Report
   Day 39 Write Report Continue
   Day 40 Review
9. **How to use larger battery packs**
   Day 41 PowerWall, Power Backup, Wind, and Solar
   Day 42 Electric Vehicle
   Day 43 Battery Management
   Day 44 Grid Tie Systems and Off Grid Systems
   Day 45 Plan 3 different Power Packs
10. **Plan 24V 20AmpHr pack**
    Day 46 Design parameters series/parallel design 18650
    Day 47 Design parameters series/parallel design 38170
    Day 48 Design parameters series/parallel design SIPIM08HP
    Day 49 Battery management control (BMC)
    Day 50 Plan Packaging
11. **Build 24V pack I**
    Days 50-55 Assemble Material and Test Batteries

12. **Build 24V pack II**
    Days 56-60 Connect batteries
13. **Build 24V pack III**
    Days 61-65 Wire and package batteries
14. **Test 24V battery packs**
    Days 66-70 Run Charge/Discharge Test
15. **Field Trip to LG Chem**
16. **Summarize and finish projects**
    - *Write report*
    - *Plan what to do with packs*
    - *Future projects*

Optional Computer sessions (these presume a large amount of out-of-class time)

1. **Arduino UNO+ introduction**
    - What is micro computing
    - What is in Starter Kit
    - What is Iterative computer program execution
    - Open design and software
2. **System design**
    - *Examine schematic drawing*
    - *I/O design*
3. **Python+ software development I**
    - *Download software*
    - *Examine libraries*
    - *Run example programs*
    - *Explore program structures*
    - *If Statements*
    - *For Statements*
    - *Case Statements*
4. **Python+ software development II**
    - *Design student program*
5. **Special Analog functions**
    - *Range and rate of change*
6. **Test project I**
    - *Measure Charge/Discharge performance*
    - *Measure Temperature effects*
7. **Test project II**
    - *Test relative performance of different designs*
8. **Report writing**
    - *Write Word document summarizing class results and future plans*

Resources:

There are direct costs to teach any class, such as:

1. Classroom
2. Work tables and chairs
3. Storage space for materials and project equipment
4. Salaries and overhead
5. Miscellaneous

In addition to these, we will need special materials and equipment, along with the space for storing in-process student projects. We plan to develop and print our own teaching hand-outs and instructions. I plan to offer the use of my Spot Welder and miscellaneous hardware to keep this classes cost down. We started our planning late and hope to have grant request for follow-up classes. This should provide an opportunity to purchase the needed equipment at that time.

We will need basic batteries, hardware, components, and test equipment:

1.	Qty 150	18650 batteries (@$1.50 + tax & ship)	250.00
2.	Qty 48	AA Batteries	20.00
3.	Qty 3	DIY Electric motor project Kits	60.00
4.	Qty 16	38170 batteries (@$10.50 + tax & ship)	200.00
5.	Qty 16	SIPIM08 batteries (@$4.50 + tax & ship)	75.00
6.	Qty 3	15S BMC 30amp (@$14.50 + tax & ship)	75.00
7.	Qty3	Imax 6b Battery charger (@$30.50 + tax & ship)	50.00
8.	Qty 2	60V adjustable DC supply (@$45.00 + tax & ship)	90.00
9.	Qty 12	Digital Multy Meters (@$9.00 + tax & Ship)	100.00
10.	Qty 26	TI4056 charge control (@$.75 + tax & ship)	20.00
11.	Qty 26	Step-Up Control (@$.80 + tax & ship)	30.00
12.	Qty 4	Battery Meter (@$18.00 + tax & ship)	75.00
13.	Qty 26	Plastic boxes(@$1.00 + tax & ship)	30.00
14.	Qty 1	50 ft. nickel strip (@$76.50 + tax & ship)	80.00
15.	Qty 1	5” wide heat shrink tube (@$35.00 + tax & ship)	45.00
16.	Qty 1	12” wide heat shrink tube (@$65.00 + tax & ship)	70.00
17.	Qty 1	.5” wide copper bar (@$95.00 + tax & ship)	80.00
		Misc Material	100.00
		Total	**$1157.00**

Follow-Up Topics for High School Classes or Projects

1. Build an all-weather electric wheelchair
2. Build off-grid power system for homes
3. Design fresh air make-up for houses
4. Advanced developments in battery technology
5. How to design a rural transportation system
6. Testing
7. Lab View
8. Design “House of the Future”
9. Repairing an electric car
10. Ultra capacitor
11. Web page design
12. Sensors and transducers
13. Software design
14. Proposal writing
15. Recycle batteries and battery raw materials
16. Recycle plastic bags
17. Process hemp to make graphene ink