

Robotics Journey

Stories, Lessons, and Projects from the Classroom

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Introduction

Robotics is everywhere from the vacuum that cleans your floor to the rovers exploring Mars. But robots are not just machines; they're about people, creativity, and imagination. This book is for anyone curious about how robots work and how we can build them. Along the way, you'll see real classroom stories, learn simple experiments, and explore the big questions about robots, from electricity basics to the future of AI.

Writer and Designer: The Engineer Mustafa Alabdallah

Chapter 1 – What is a Robot?

When most people hear the word robot, the first image that comes to mind is often something from science fiction: a shiny metal figure that walks and talks like a human, or maybe a giant machine with glowing eyes and a mechanical voice. But in reality, most robots don't look anything like humans. They come in many different shapes and sizes, designed not to look impressive, but to do very specific jobs.

At its core, a robot is any machine that can sense, decide, and act. These three steps are what separate a robot from an ordinary machine. First, a robot must sense the world around it. Just as we humans use our eyes to see, our ears to hear, and our skin to feel, robots use sensors to detect light, sound, distance, temperature, and countless other things. Next, a robot must decide what to do with the information it gathers. This “thinking” is usually done by a small computer or a microcontroller the robot's brain. Finally, the robot must act. It might move its wheels, swing an arm, or even just turn on a light, but some kind of action must happen for the robot to truly come alive.

Consider something as ordinary as a robot vacuum cleaner. It has sensors that tell it where the walls and furniture are, a computer inside that decides which way it should move next, and motors that spin its wheels so it can sweep across the floor. Even though it doesn't look like a person, it is still very much a robot, because it senses, decides, and acts.

Once you start to think about robots in this way, you'll notice they are everywhere. In hospitals, tiny robots assist doctors in surgeries, performing movements so delicate that human hands could never match their precision. In factories, large robotic arms build cars, place electronic parts on circuit boards, and even package food for the supermarket. Out in space, rovers like *Curiosity* and *Perseverance* explore the surface of Mars, sending back pictures and data that expand our understanding of the universe. At home, robots clean, cook, and even play with us.

One way to think about a robot is to compare it to a student in class. The student uses eyes and ears to sense what the teacher is saying and showing. The brain processes this information, deciding what to write down or how to answer a question. Finally, the student acts by raising a hand, solving a problem, or walking to the board. Robots function in the same way: sensors are their eyes and ears, the microcontroller is their brain, and motors are their hands and legs. And just like students, robots sometimes do unexpected things, especially if they don't fully understand the instructions they've been given!

So, what truly makes a robot special is not how it looks, but how it behaves. A washing machine that follows a set of steps isn't really a robot it doesn't sense, it just runs a program. But the moment you add a sensor to detect water levels or imbalance, and the machine changes its behavior in response, it starts to cross the line into robotics. Robots are machines that interact with the world, and that interaction is what makes them so fascinating.

Almost like anything else the world of Robotics must have laws, we will dive into those Laws written by Isaac Asimov's science stories. These rules were meant to keep humans safe and robots under control, but as you'll see, even the smartest rules can lead to surprising dilemmas.

Chapter 2 – The Laws of Robotics

If you've ever seen the movie *I, Robot* or read Isaac Asimov's famous science fiction stories, you've probably heard about the Three Laws of Robotics. They were written as a way to make sure robots would always serve humans safely. On paper, they sound perfect. In practice, they raise more questions than they answer.

The three laws are:

- 1) A robot may not injure a human being, or through inaction, allow a human being to come to harm.
- 2) A robot must obey the orders given it by human beings, except where such orders would conflict with the First Law.
- 3) A robot must protect its own existence, as long as such protection does not conflict with the First or Second Law.

At first glance, these laws seem simple and logical. Of course robots shouldn't hurt people. Of course they should listen to us. And of course they should keep themselves safe so they can continue working. But when you put all three together, you quickly find contradictions. What happens if a robot has to choose between two humans in danger saving one would mean not saving the other. Has it broken the First Law? What if a human gives an order that could indirectly harm another person? Should the robot obey or disobey?

These dilemmas are not just science fiction. Think about self-driving cars. Imagine a car driving down the road when suddenly a child runs across the street. If the car swerves to avoid the child, it might crash and injure the passenger. If it doesn't swerve, the child could be hurt. There's no easy answer, and whichever choice the robot makes, it will have followed one law but broken another.

Another real example comes from military robots. If a robot is ordered to attack a target, but that action risks harming civilians, it faces the same impossible choice: obey the human command (Law 2) or protect human life (Law 1). Suddenly, the simple rules become a puzzle.

I often discuss these laws with my students in class, and it always leads to lively debates. Some students argue that robots should always follow orders after all, they are machines. Others say safety comes first, no matter what. And then there are those who see the problem more deeply: the rules sound good, but life is full of gray areas that robots can't easily calculate.

The beauty of the Three Laws is that they spark questions, not answers. They force us to think about what we really expect from robots. Do we want them to be our servants, our protectors, or maybe even our partners? These are not just questions for science fiction they are questions for our future.

For the time being we are discussing theoretical situations, But don't worry I am not trying to bore you to death, we'll step away from philosophy and get practical. Before a robot can follow any rules at all, it needs energy. It needs life. And for robots, life begins with electricity.

Chapter 3 – Master Of Both Worlds

Every living thing needs energy to survive. For humans, it's food. For cars, it's fuel. For robots, it's electricity. Without electricity, a robot is nothing more than a pile of parts it can't think, sense, or move. Electricity is the heartbeat that gives robots life.

But what is electricity, really? I like to explain it to my students using something we all understand: water. Imagine a system of pipes. The water flowing through the pipes is like electric current; it represents how many electrons (tiny particles that carry charge) are moving through a wire. The water pressure is like voltage; the push that makes the electrons move. Finally, if the pipe is narrow, it resists the flow of water. That's resistance; the part of the circuit that slows down or controls the current.

So, when we talk about Ohm's Law (the most important law in electricity), it's simply this:

Voltage = Current \times Resistance.

Or in our water example: Pressure = Flow \times Pipe Size.

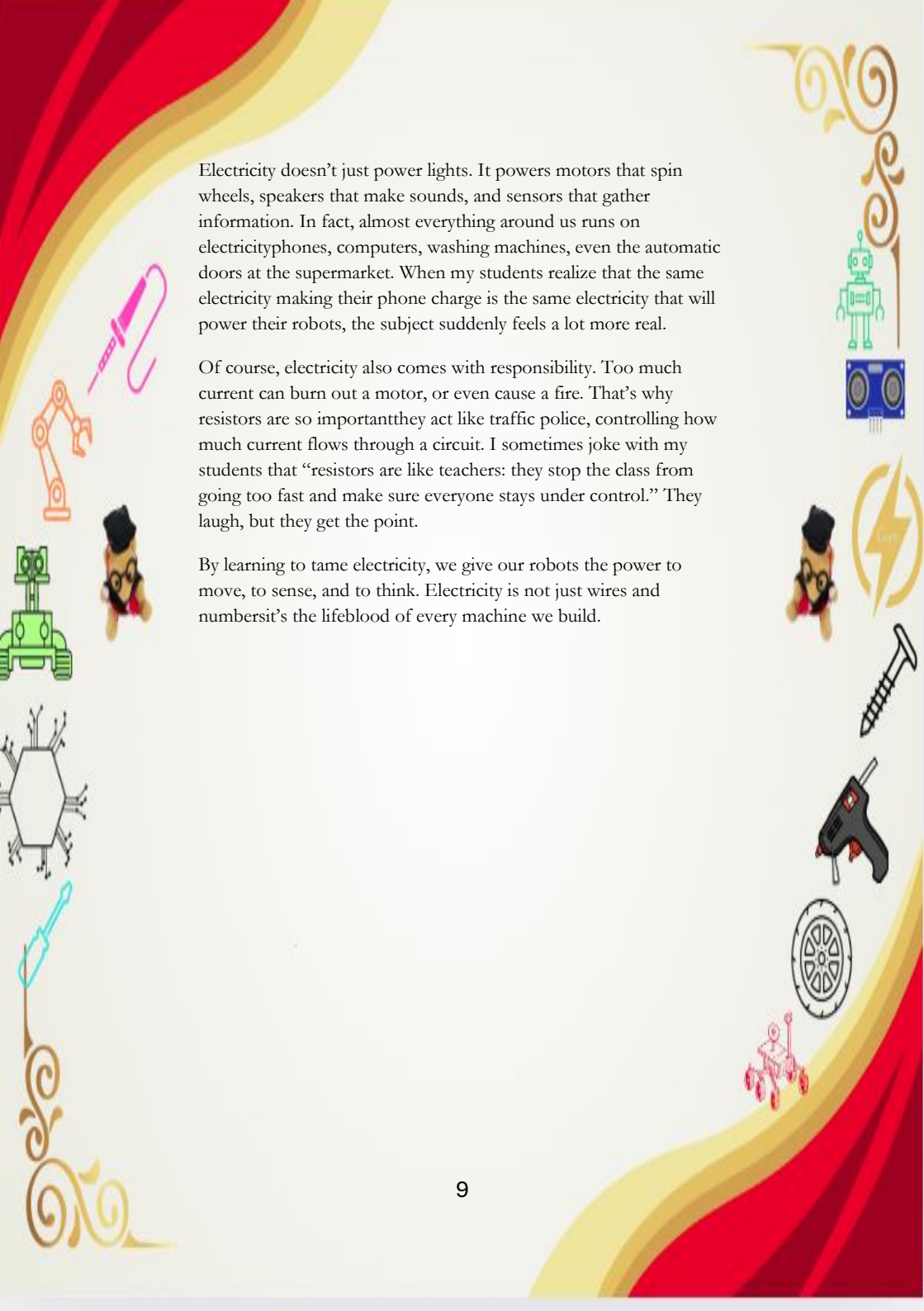
Electricity can feel invisible and mysterious, but the truth is, it behaves in very predictable ways. Once you understand the basic relationship between voltage, current, and resistance, you can start to control it. And when you can control electricity, you can control robots. Understanding these concepts and explaining them are two different worlds and as a teacher you must be a master of both worlds.

In class, one of the most magical moments is when a student first lights an LED. It sounds small, but for many of them, it's their first experience creating something that comes alive with electricity. They connect a battery, a resistor, and a tiny LED bulb. At first, nothing happens. Then, after checking the connections, suddenly the bulb glows. That tiny spark shows them that they can control energy and from that moment, they're hooked.

Electricity doesn't just power lights. It powers motors that spin wheels, speakers that make sounds, and sensors that gather information. In fact, almost everything around us runs on electricity—phones, computers, washing machines, even the automatic doors at the supermarket. When my students realize that the same electricity making their phone charge is the same electricity that will power their robots, the subject suddenly feels a lot more real.

Of course, electricity also comes with responsibility. Too much current can burn out a motor, or even cause a fire. That's why resistors are so important—they act like traffic police, controlling how much current flows through a circuit. I sometimes joke with my students that "resistors are like teachers: they stop the class from going too fast and make sure everyone stays under control." They laugh, but they get the point.

By learning to tame electricity, we give our robots the power to move, to sense, and to think. Electricity is not just wires and numbers—it's the lifeblood of every machine we build.



Chapter 4 – The Parts of a Robot

If electricity is the lifeblood of a robot, then its body is made of parts that each serve a special role. Just like humans have eyes, ears, muscles, and a brain, robots are built from components that give them senses, movement, and intelligence. Once you understand these parts, robots stop looking like mysterious machines and start feeling familiar almost alive.

Let's start with the sensors, the robot's eyes and ears. Sensors give robots the ability to notice the world around them. A light sensor can tell when a room is dark or bright. An ultrasonic sensor can measure how far away an object is, much like how bats use sound to navigate. Temperature sensors, infrared sensors, and cameras all allow robots to collect information. Without sensors, a robot would be blind and deaf, unable to react to anything.

Next comes the controller, which acts as the robot's brain. This is usually a small computer called a microcontroller, such as an Arduino or Raspberry Pi. The controller takes in the information from the sensors, makes decisions, and then sends instructions to the motors or other parts of the robot. You can think of it as the place where "thought" happens. Of course, robots don't think like humans do they follow lines of code written by people. But in a way, every line of code is like a thought we've planted in the robot's brain.

Now let's look at the actuators, the robot's muscles. Actuators are the parts that move motors that spin wheels, servos that lift arms, or even hydraulic pistons in large industrial robots. Whenever you see a robot in action lifting, turning, rolling, or grabbing actuators are at work. Without them, a robot could sense the world and think about what to do, but it could never actually act on those thoughts.

Of course, all of this needs power, and that's where the **battery** comes in. If electricity is the lifeblood, the battery is the heart. It pumps energy through the robot's wires so everything can function. Small classroom robots usually run on simple rechargeable batteries, while large machines might use high-capacity power systems. Either

way, without a steady energy source, even the smartest robot is nothing more than a statue.

I sometimes ask my students to imagine building a “robot version” of themselves. Their eyes would be replaced by cameras, their ears by microphones, their arms and legs by motors and servos, their brain by a controller, and their stomach by a battery pack. Suddenly, the idea of a robot doesn’t seem so alien—it’s just another version of us, built from metal and wires instead of flesh and bone.

Understanding the parts of a robot is the first step toward building one. Once students see how each part connects—the sensors feeding information to the brain, the brain commanding the muscles, the battery keeping it all alive—they begin to understand that robotics is not magic. It’s engineering. It’s design. And most importantly, it’s something they can do too.

In the next chapter, we’ll move from theory to practice. We’ll look at the first hands-on projects that students can build, and how even something as simple as lighting an LED or spinning a small motor can feel like bringing a robot to life.

Chapter 5 – Middle School Makers

If preschoolers are curious explorers and high schoolers are ambitious builders, then middle school students are something else entirely: a storm. They are at the age where energy, curiosity, and stubbornness collide. Teaching robotics to them can feel like juggling batteries, wires, and fireworks all at once. But if you manage that storm, you'll find sparks of brilliance hidden inside.

Middle school is the “spark age.” This is when kids start asking not just “what” but “why.” Why does the motor spin this way? Why can't we use two sensors instead of one? Why do we even need code if we can just press a button? These questions can be exhausting, but they're also golden. A classroom full of “why” means you're doing something right.

Of course, not every “why” is deep. Sometimes it's a challenge. I once had a student ask, “Why do we even need robots if we have people?” At first it felt like sarcasm, but I turned it into a discussion. We talked about robots in hospitals, in space, in factories. Suddenly, the class that started with one skeptical question turned into one of the most engaged debates we ever had. The trick is not to shut down their challenges, but to flip them into opportunities.

The chaos, though, is real. Middle schoolers love to test limits. One group will build too fast and break things. Another will move too slowly and lose focus. Some will argue about whose turn it is to plug in a cable. This is where structure saves the day. My system of assigning group managers, giving rewards for curiosity, and turning helpers into mini-teachers works especially well at this level. The spotlight of responsibility is something they crave, and when used wisely, it transforms chaos into teamwork.

But sometimes the chaos teaches its own lessons. I'll never forget the time a group proudly announced they had “optimized” their robot. They pressed run, and the robot took off so fast it flew off the table and crashed onto the floor. The whole class erupted in

laughter. I could have scolded them, but instead we treated it as a case study. Why did it happen? How do we balance speed and control? That crash turned into a lesson about engineering trade-offs, one they never forgot.

Middle schoolers also respond well to competition. A simple race between two robots can light up the room more than any lecture. Add a scoreboard, a time limit, or even a silly prize, and suddenly everyone is focused. Competition channels their natural energy into something productive. But it has to be balanced with collaboration, because too much competition can create tension. That's why I like to mix it: group projects for teamwork, mini-competitions for excitement.

Something to keep in mind: middle school students don't just need you to teach them robotics, they need you to model how to handle challenges. If you get frustrated when the robot doesn't work, they will too. If you laugh, troubleshoot, and keep going, they'll follow. At this age, they copy not only your knowledge but also your attitude.

In the end, middle school is messy. But it's also magical. The noise, the arguments, the constant questions, they're all signs of a mind trying to grow. When you guide that storm into creation, you get moments where a student who was sure "this is impossible" suddenly shouts, "It works!" And that spark, once lit, never really goes out.

Chapter 6 – High School Hackers

High school is a different battlefield. By this age, students have already been through years of schooling, tests, and endless homework. Many of them are tired, burned out, or simply uninterested in yet another subject. Some don't even want to continue school, and they see every class as one more obstacle before freedom. Trying to grab their attention is one of the hardest tasks a teacher can face. But when you do succeed, the reward is worth it: these same students, when inspired, can produce robotics projects so advanced that you forget they're still teenagers.

The first challenge with high schoolers is personality. They are sharper, more opinionated, and more likely to challenge authority. Some will walk into the room with headphones still on, arms crossed, already signaling "I don't care." Others will dive into the lesson but in their own way, questioning not just the project but your entire approach. At first, I thought this was disrespect. Later, I realized it was actually an invitation. High schoolers test you because they want to see if you're real. If you stay calm, confident, and authentic, they slowly give you their respect. If you try to "fake it," they'll see through you in a second.

With their personalities come their rhythms. Many are exhausted from exams, late-night gaming, part-time jobs, or just the weight of being a teenager. That's why long lectures are a recipe for disaster. I learned to break lessons into smaller chunks, mixing theory with hands-on activity. Ten minutes of explanation, then "let's try it." If they're building, coding, or experimenting, they're awake. If they're just listening, half the class is gone.

The second challenge is the projects themselves. By high school, students are ready for more advanced robotics work: Arduino projects with multiple sensors, 3D printing parts, programming autonomous cars, even experimenting with drones. These projects are exciting, but they're also complex. The more advanced the project, the more specific the problems. Suddenly, a lesson can stall because one group's ultrasonic sensor isn't calibrated, or a 3D print

failed halfway through. Managing these technical issues while keeping the rest of the class engaged is a juggling act. Sometimes it feels like you need three pairs of hands just to keep things moving.

But this is also where the magic happens. When a high school student really connects with a project, they run with it. I've seen students who seemed bored at first come alive when building something they care about like a football-score counter using sensors, or a smart lamp controlled by an app. Once they find the link between robotics and their personal interests, they're unstoppable. The same student who used to put their head down on the desk can suddenly stay after class, tweaking code until the project runs just right.

Of course, not every moment is inspiring. There were times when I felt like I was fighting a losing battle. Students arguing, equipment breaking, the whole room looking like they'd rather be anywhere else. But even on those days, I reminded myself: high school is hard for them too. They're under pressure from parents, teachers, and themselves. Sometimes robotics is the one space where they can experiment, fail safely, and not feel judged. If you give them that space, they will surprise you.

One story I'll never forget was a group of students who decided to design a robotic arm for a science fair. At first, they were half-hearted, distracted, and not really working. But as the deadline got closer, something shifted. Suddenly, they were staying late, arguing passionately over servo angles, and printing new designs overnight. On presentation day, their arm worked perfectly, and their pride was written all over their faces. That moment reminded me that with high schoolers, patience is everything. They may start slow, they may complain, but if you give them responsibility and time, they can rise far beyond expectations.

One of my favorite memories with high schoolers came from a student who, at first, wanted nothing to do with robotics. He would sit in the back, arms folded, making jokes during explanations. Every time I asked him to join an activity, he'd shrug and say, "Robotics isn't for me." Instead of pushing too hard, I tried a different approach. I asked him about his hobbies. He said he loved football. So, I challenged him: "What if we build a robot that can help him sprint faster or score more accurate?" His eyes lit up for the first time in class. Over the next few weeks, he became the most focused student in the group, coding a system that used sensors to boost his hip movement when running. On the final day, he demonstrated it proudly in front of his classmates. The same student who once wanted to disappear into the back of the room was now standing in the front, explaining his code. That moment showed me something important: sometimes the key to unlocking a student's potential is simply connecting robotics to what they already love.

Trust me on this one: with high school students, the key isn't to force attention. It's to earn it. Speak honestly, connect robotics to their world, and let them lead when possible. Give them projects that feel real, not just exercises. They might act bored, but deep down, they're looking for something meaningful. And if you can show them that robotics has meaning, you'll not only teach them how to build machines, you'll help them see they can build a future too.

Chapter 7 – The Teacher's Toolbox

Every craftsman has a toolbox, and for a robotics teacher, that toolbox is as important as the lesson plan. It's not just wires and sensors; it's the foundation that holds the entire class together. Over the years, I've learned which tools are essential, which ones are just nice extras, and which ones will almost definitely break the moment you need them most.

The essentials are simple but powerful. An Arduino board, a breadboard, jumper wires, LEDs, and a few sensors are enough to teach the core of robotics. With these, students can already build projects that feel magical: blinking lights, distance detectors, small moving robots. These basics may not look impressive compared to a 3D printer or a drone, but they teach the foundations every student needs. If you're starting from scratch, this is where you begin.

Then come the "wow" tools. A 3D printer that brings designs to life. A VR headset that lets students imagine robotics in another dimension. A drone that buzzes above the classroom, making every head turn. These aren't necessary to teach robotics, but they create unforgettable moments. The danger is when schools buy flashy tools but ignore the basics. A drone is exciting, but if you don't have enough motors or batteries for the robots, the excitement fades quickly. Balance is everything.

And then there are the heartbreakers—the tools that always fail at the worst time. Motors that stop spinning mid-class. Bluetooth modules that suddenly refuse to connect. Soldering irons that burn out, sometimes on the same day you replace them. I've had entire lessons derailed because one piece of equipment decided it was tired. At first, I used to panic. Now I treat it as part of the lesson: "This is engineering. Things break. How do we fix it?" Students learn just as much from the failure of equipment as they do from its success.

What most people don't see is the hidden side of the toolbox: the small, unusual items that have nothing to do with robotics but save the day more than any sensor or motor. A roll of tape has fixed more lessons than I can count. A spare USB cable has prevented a full meltdown when the original stopped working. I once even kept

a bag of chocolate in my bag, because I realized that sometimes the fastest way to calm down a frustrated group was to give them a sweet break before trying again. Over time, I learned that being a robotics teacher is like being half-engineer, half-magician. The students see the robots, but behind the curtain, you're juggling chargers, adapters, and backup plans for when the projector refuses to turn on.

These little lifesavers may not look impressive, but they're what keep the class moving forward. The truth is, your toolbox is not just hardware it's your ability to anticipate problems and carry solutions that no one else thinks about. A teacher without tape, markers, or backup batteries is like a soldier without armor. The robots may fail, but your backup plan cannot.

A classroom truth: your toolbox isn't just about hardware, it's about mindset. Every tool is an opportunity. An LED is a chance to teach electricity. A broken motor is a chance to teach resilience. A 3D printer is a chance to teach creativity. Don't obsess over having the biggest, fanciest toolbox. Focus on how you use what you have. The most powerful tool you carry into class is not the Arduino or the soldering iron it's the way you turn every piece, even the broken ones, into a lesson.

Chapter 8 - The Chaos Principle

If there's one rule in robotics teaching, it's this: nothing ever goes exactly as planned. The robot that worked perfectly yesterday refuses to move today. The Wi-Fi drops in the middle of a coding challenge. A battery that was fully charged dies after two minutes. Chaos isn't an accident in robotics classes—it's the default setting.

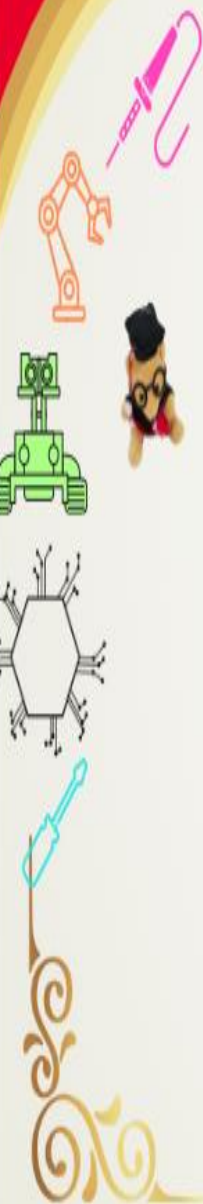
At first, chaos terrified me. I thought a "good teacher" was someone who kept everything under control, every wire in place, every project working smoothly. But reality taught me a different lesson: the most powerful learning moments often come from the chaos. When a robot spins in circles instead of moving straight, the class doesn't just see a failure—they see a mystery. Why did this happen? What did we miss? Suddenly, everyone is engaged, not because the robot worked, but because it didn't.

One of my most unforgettable chaotic moments was during a race between student-built robots. The countdown started, the robots were placed at the line, and the whole class leaned forward in anticipation. "Three, two, one, go!" One robot shot forward, the other spun violently and flew off the table. The classroom erupted in laughter. Instead of calling it a disaster, I asked, "What can we learn from this?" That crash turned into a lesson about balance, calibration, and design limits. The students who "failed" ended up understanding more than the ones who won.

In order to use chaos well, you have to stay calm. Students mirror your reactions. If you panic, they panic. If you laugh and troubleshoot, they do the same. Over time, I trained myself to respond to chaos with curiosity. Instead of saying, "It's broken," I'd say, "Interesting... let's investigate." That small shift changed the atmosphere in the room. Suddenly, chaos wasn't a threat—it was an invitation.

Here's what I learned the hard way: don't measure your lessons by how smooth they are. The quietest class isn't always the most successful, and the noisiest isn't always a failure. In robotics, chaos is proof that something real is happening. Students are experimenting, testing limits, and learning in the mess. And sometimes, in the

middle of the noise and broken robots, you'll find the spark that makes the whole lesson unforgettable.



Chapter 9 – More Than Robots

When people hear “robotics teacher,” they imagine wires, motors, and lines of code. But the truth is, robotics is never just about robots. It’s about the life skills hidden inside every project, the human lessons that stay with students long after they forget how to program an Arduino.

Robotics teaches teamwork in the most natural way. You can’t build a functioning robot alone in a classroom full of twenty students. Someone has to connect the wires, someone has to code, someone has to document, and someone has to present. In every project, students discover their strengths. The quiet student who doesn’t like speaking might become the fastest problem-solver on the team. The loudest student might not be the best at coding, but suddenly shines as the team leader. A robot becomes the mirror that shows them who they are in a group.

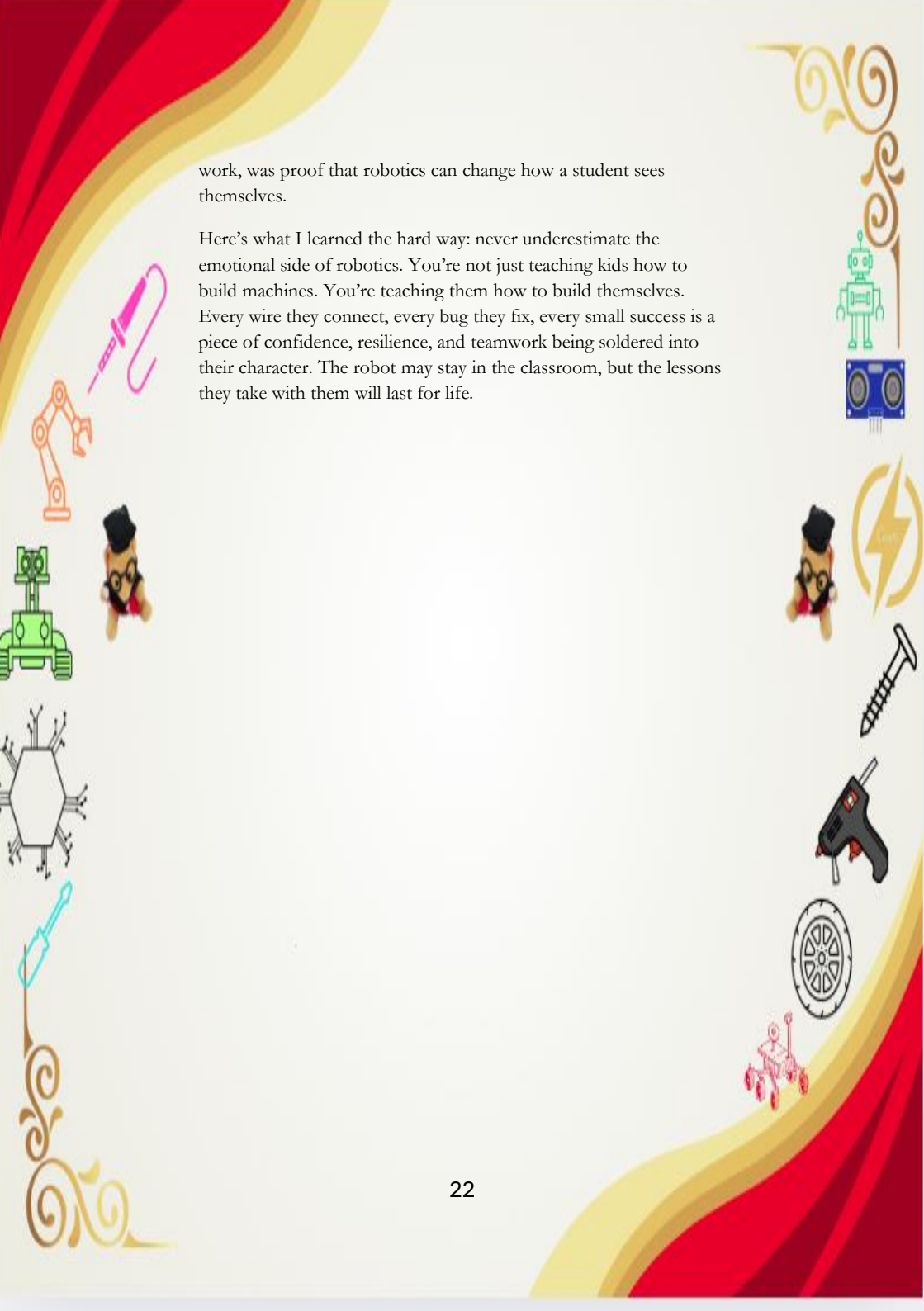
It also teaches resilience. Robots almost never work the first time. Code crashes, sensors misread, motors burn out. At first, students get frustrated. “It doesn’t work!” they shout. But over time, they learn that this is normal. Failure is part of the process. The best moment is when a student who once gave up easily learns to try again, and again, and again until the robot finally moves. That persistence is a skill they can carry into every challenge in life.

Creativity is another hidden gift. Ask a class of students to build a robot car, and you’ll never get two identical results. Some will add decorations, others will try unusual designs, some will even code special features no one asked for. The project may be the same, but the creativity makes it unique. Robotics gives students permission to imagine, to experiment, to turn “what if” into “let’s try.”

And then there’s confidence. I’ve seen students who struggled in every subject come alive in robotics. One boy who rarely spoke in class lit up when his team’s robot worked, and for the first time he volunteered to present in front of everyone. Another student who always said, “I’m not smart” ended the semester leading a group project. The pride in their voices, the way they looked at their own

work, was proof that robotics can change how a student sees themselves.

Here's what I learned the hard way: never underestimate the emotional side of robotics. You're not just teaching kids how to build machines. You're teaching them how to build themselves. Every wire they connect, every bug they fix, every small success is a piece of confidence, resilience, and teamwork being soldered into their character. The robot may stay in the classroom, but the lessons they take with them will last for life.



Chapter 10 – Show, Don't Tell

One of the first things I learned as a robotics teacher is that talking too much can kill a lesson. You can explain how electricity flows, how code loops work, or how sensors detect distance but if students don't see it, it stays abstract. The moment you flip a switch and a robot comes to life, everything changes. Eyes widen, hands shoot up, and curiosity takes over. In robotics, showing is always stronger than telling.

That's why I try to keep my explanations short and my demos frequent. Instead of lecturing for twenty minutes about how an ultrasonic sensor works, I place one on a robot and let it move. The students hear the clicking sound, watch the robot stop before hitting the wall, and suddenly they understand. The demonstration becomes the explanation, in some cases it's best to use the whole method which is tell, show, watch go .

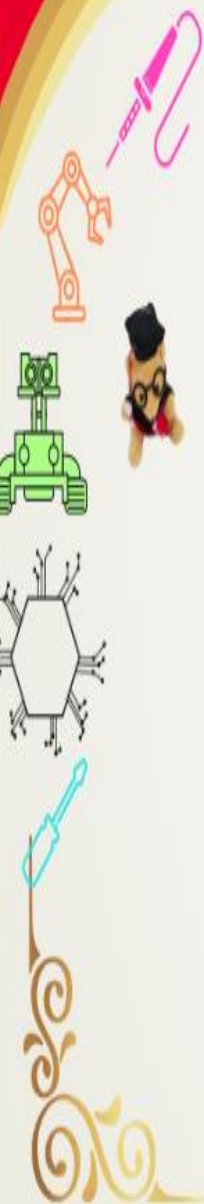
But it's not only about me showing them. It's just as important to let students show each other. I love making time for mini-presentations where groups share what they built, even if the robot only half works. When students become the ones "telling," it doesn't stick as much. When they *show* their classmates a moving project, the room comes alive. One student's success becomes the spark for another student's idea.

Adding visuals is another secret weapon. A carefully designed presentation, a short video, or a quick animation can make concepts clear in seconds. I spend time making my slides colorful and clear, because I know that for most of the lesson, that's what the students are looking at. If the slides are boring, the class drifts away. If they're engaging, the students lean in. I sometimes spice things up with a Kahoot quiz or a funny video clip, because showing information in different ways keeps attention alive.

And then there's the unexpected showing. I've had moments where a project failed in the middle of a demo, and instead of hiding it, I used it. "Look, the motor stopped. Why do you think that happened?" Suddenly, the whole class is investigating. By showing the failure, I taught more than I ever could with a polished demo.

Students don't just need to see success; they need to see the process, the mistakes, the problem-solving in action.

As a teacher if you want students to remember your lessons, show them something they can't forget. A robot that spins in circles, a light that flashes to music, a code bug that turns into a funny dance. These moments live in their memory far longer than any slide or explanation. Show them the magic, let them show it to each other, and you'll never have to force their attention they'll give it to you willingly.



Chapter 11 – Fail Forward

Failure is the best teacher in robotics. No matter how carefully you prepare, projects fail: robots don't move, code crashes, wires disconnect. For students, failure feels like defeat. For teachers, it feels like losing control. But failure is the spark that pushes growth.

I started teaching my students a simple motto: "Fail forward." Every mistake is a step closer to success. The motor that spins the wrong way teaches more about polarity than any slide. The robot that crashes into a wall teaches more about sensors than a perfect demo ever could.

And it wasn't just my students failing. I failed too. Once, I wired an Arduino backwards during a demo and fried the board in front of everyone, which even triggered the sprinklers. At first, I felt embarrassed. But then I tried to turn it into a lesson: "See? Even teachers mess up. The key isn't to avoid mistakes. It's to learn quickly and move forward." It was during the summer and Ironically, the school had water activities planned that same day, but they also understood that failure is part of the process for everyone.

Some of my best memories come from failed projects that turned into discoveries. A robot meant to move in a straight line that spun in circles became a lesson about calibration. A drone that refused to lift off became a discussion about battery power, total weight of the drone, and the direction of its motors. When students realize that every failure hides a lesson, they start approaching robotics not with fear, but with curiosity.

Here's what I wish someone told me: don't shield your students from failure. Guide them through it. Let them feel the frustration, but also show them the path forward. In robotics, success isn't about never failing. It's about never stopping.

Chapter 12 – Classroom Hacks That Saved My Life

Over time, I've collected a set of hacks that keep me alive as a robotics teacher. These aren't in any manual. They're the little tricks that make the difference between a smooth lesson and total collapse, and if you have been paying attention, I put a pro tip you'r welcome.

One of the most overlooked hacks is planning the flow of the lesson, not just the content. I learned to always keep a five-minute backup activity in my pocket something quick, simple, and fun for those moments when the robot refuses to cooperate. It could be a logic puzzle, a short Kahoot quiz, or even asking students to sketch their "dream robot" on paper while I troubleshoot the hardware. These fillers don't feel like wasted time; they keep energy alive and prevent frustration from taking over. Another trick is music I sometimes play upbeat tracks quietly in the background while students build (Lo-Fi study music or Brain.fm are perfect). It keeps the atmosphere light and helps them focus. Finally, I started using my phone to take quick pictures of projects in progress. Students love seeing their work documented, and it turns unexpected downtime into an opportunity to celebrate their effort. These simple hacks don't cost much, but they transform dead moments into moments of creativity.

Pro tip: the difference between chaos and control often comes down to the small habits no one teaches you. Build your own set of hacks. They'll save you more times than you realize.

Chapter 13 – Mentoring the Mentors

One of the greatest privileges in my journey has been mentoring new robotics teachers. Many of them walked into their first class with the same fear I once had: “What if I don’t know enough? What if the students ask something I can’t answer? What if everything breaks?”

I tell them the same thing: something will break, and that’s okay. A good robotics teacher isn’t someone who has all the answers, but someone who models curiosity and persistence. When a sensor doesn’t respond, the students don’t expect perfection they expect you to try, to test, to troubleshoot.

I shared with new teachers my Three Builds Rule (robots, student skills, and yourself), with the (tell show watch go) method, my group manager system for teamwork, and the Chaos Principle that turns accidents into lessons. Slowly, they grew more confident. I still remember the first time one of my trainees ran their own class. They were nervous, but at the end, the students were smiling and engaged. That teacher later told me, “I thought I had to be the expert. But I realized I just had to be the guide.”

A classroom truth: when you mentor teachers, you multiply your impact. Every teacher you help is another group of students who get to experience robotics. Mentoring doesn’t just shape classrooms. It shapes futures.

Chapter 14 – Teaching Beyond Robotics

Robotics is my main stage, but I've also taught English in college and full-stack programming in private lessons. At first, I thought these experiences were separate. But I soon realized that teaching is never just about content.

In English classes, I saw students struggle with grammar but light up when they connected the language to their lives. In programming lessons, I watched students get stuck on logic but beam with pride when their code finally ran. In robotics, it's the same story: struggle, breakthrough, pride. Different subjects, same human journey.

What connects all teaching is not the material but the relationship. Students don't always remember the exact details of a lesson, but they never forget how you made them feel. Making them believe they could do it and giving them the courage to try again are essential, especially at college level teaching.

In short don't put yourself in a box. Whether you're teaching robotics, English, or code, your real job is to inspire. The subject changes, but the mission is always the same to help students see themselves as capable of more than they believed.

Chapter 15 – The Burnout Battle

Passion is powerful, but it's not endless. After years of teaching in multiple schools, racing between buses and trains, studying late into the night, and managing countless projects, I began to feel the slow weight of burnout pressing on me. Some days I walked into class exhausted, and the students could feel it instantly. Energy is contagious, and when mine was low, the entire room dimmed. I used to think being tired was just part of the job that if I pushed harder, the spark would return. But pushing harder only made the fire fade faster. Burnout doesn't arrive in one dramatic moment; it creeps in quietly, turning something you love into something that feels heavy.

I had to learn to protect my fire before it went out completely. That meant setting limits, resting when I could, and admitting to myself that I couldn't do everything for everyone. I began saying no to projects that stretched me too thin and carving out time to simply breathe. Instead of treating teaching robotics as another duty on a long checklist, I reminded myself why I loved it in the first place: the curiosity in a student's question, the shared laughter when something failed in a funny way. Slowly, I built rhythms that allowed me to keep going without collapsing. I learned that self-care wasn't selfish—it was survival.

Frankly burnout is dangerous. It doesn't only drain your energy; it steals your creativity, your patience, and your joy. If you don't take care of yourself, you can't take care of your students. Build pauses into your schedule, even small ones. Find moments to recharge your mind and body, whether it's through a walk, a hobby outside teaching, or just a quiet cup of hot cocoa without interruption. Most importantly, don't forget the reason you started teaching robotics in the first place. That spark that pulled you into this world is your anchor when things get heavy. A teacher who rests doesn't just survive the classroom; they return with energy that inspires, with presence that fills the room, and with passion that lasts for the long run.

Chapter 16 – The Unexpected Lessons

I thought I was going to teach students about robots. But in many ways, they ended up teaching me.

They taught me patience when I explained something ten times before it finally clicked. They taught me creativity when they found solutions I never thought of. They taught me humor when everything went wrong.

One lesson that stayed with me came from a student who struggled with academics. He rarely spoke, and other teachers had written him off. But in robotics, he came alive. He built quietly, steadily, and when his robot worked, he smiled for the first time in weeks. He reminded me that students aren't defined by grades they're defined by opportunities.

Anyone can be a teacher if you listen close enough, stay open to learning from your students. Teaching is not one-way. The more you listen, the more you grow alongside them.

Chapter 17 – Robotics Across Borders

Teaching in Arabic, Hebrew, English and sometimes Russian wasn't always easy, but it became one of the most rewarding parts of my journey. At first, switching between languages felt like extra work. But soon, I realized robotics itself is a universal language.

I've seen Arabic-speaking and Hebrew-speaking students working side by side, building robots together, laughing at code bugs, and celebrating when their project succeeded. In those moments, it didn't matter what language they spoke curiosity sounded the same.

One memory I treasure is a mixed group that struggled at first to communicate. Instead of giving up, they started using gestures and drawings to explain ideas. By the end, they weren't just building robots they were building friendships across cultures.

In conclusion robotics doesn't just connect wires. It connects people.

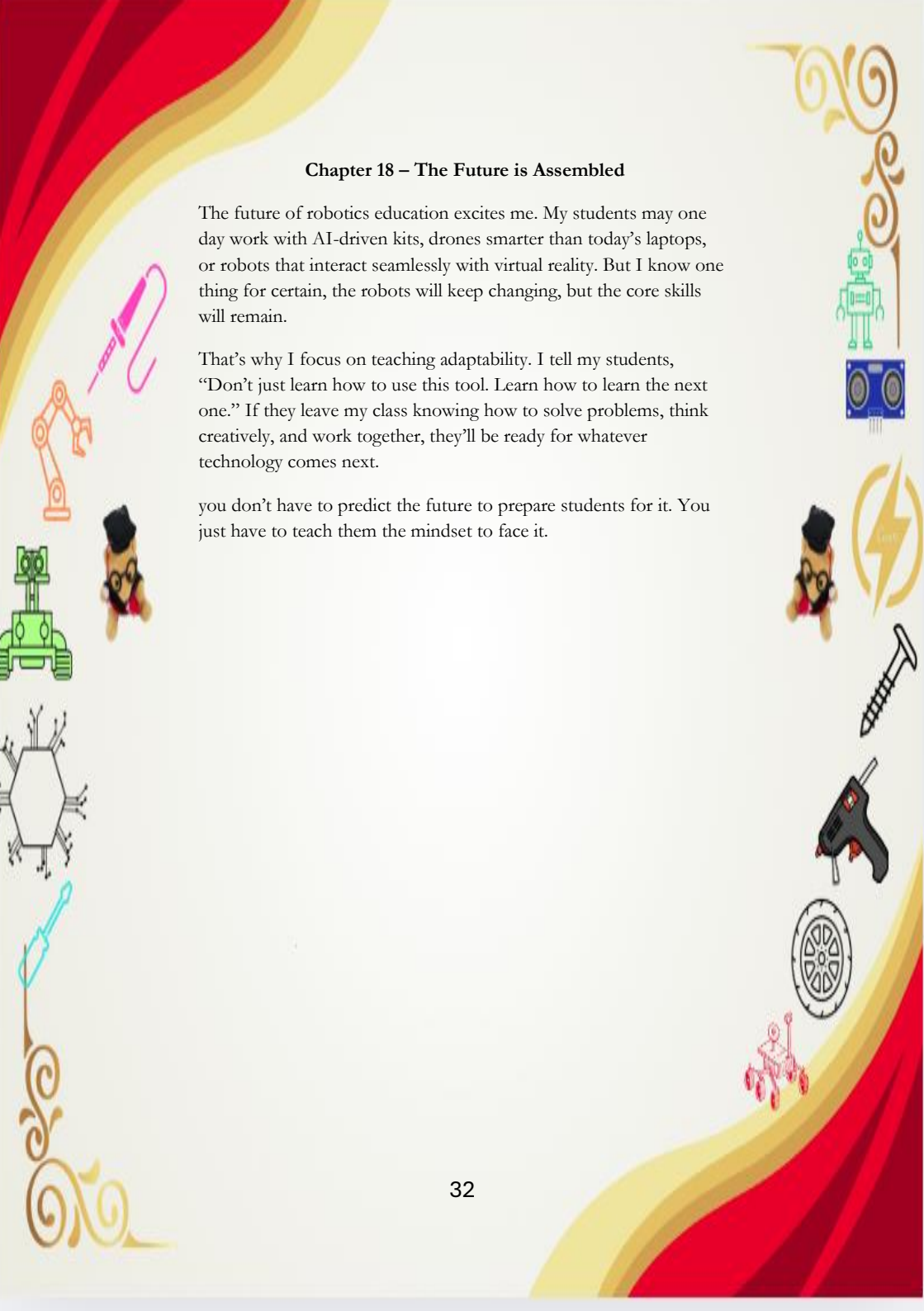


Chapter 18 – The Future is Assembled

The future of robotics education excites me. My students may one day work with AI-driven kits, drones smarter than today's laptops, or robots that interact seamlessly with virtual reality. But I know one thing for certain, the robots will keep changing, but the core skills will remain.

That's why I focus on teaching adaptability. I tell my students, "Don't just learn how to use this tool. Learn how to learn the next one." If they leave my class knowing how to solve problems, think creatively, and work together, they'll be ready for whatever technology comes next.

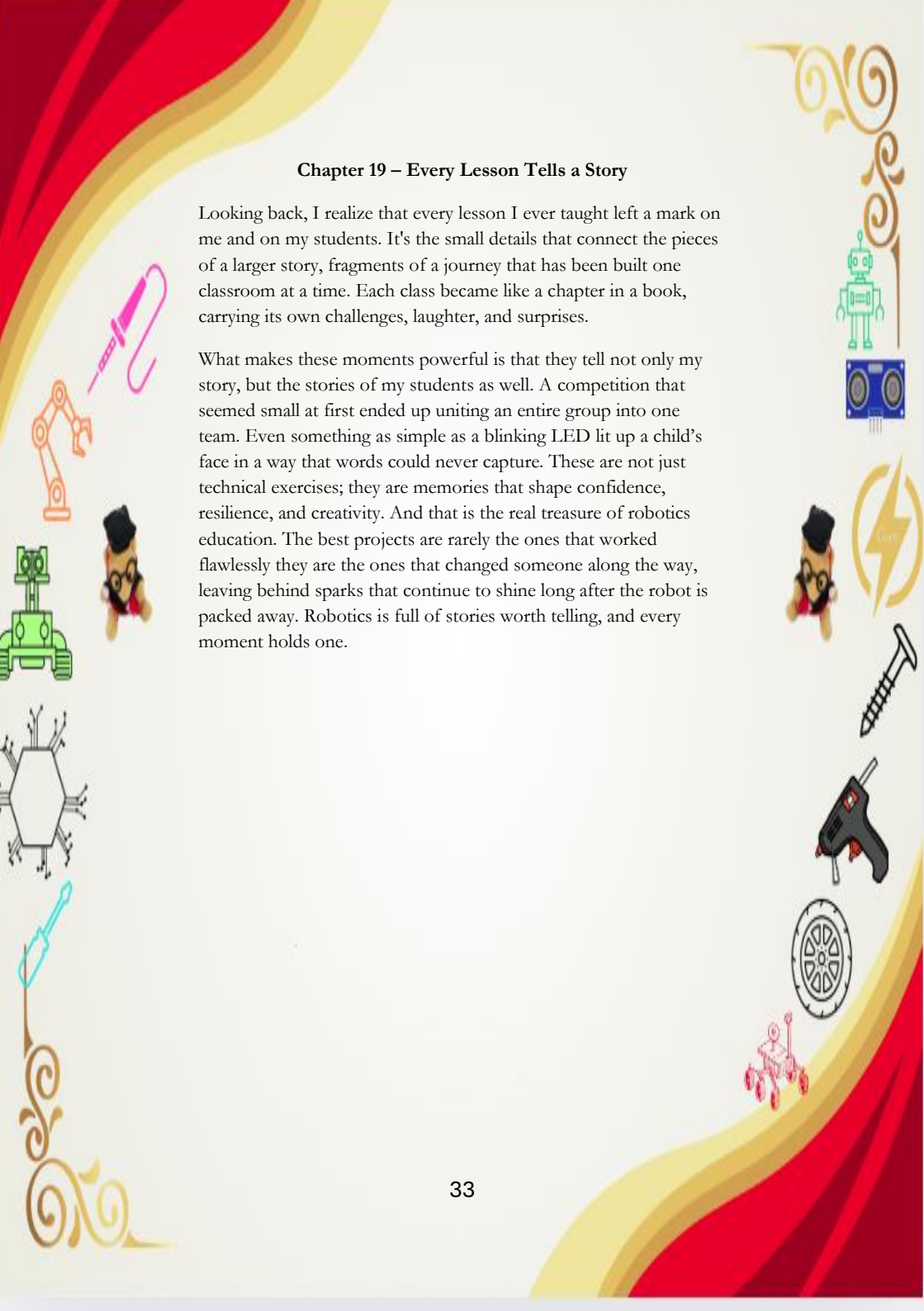
you don't have to predict the future to prepare students for it. You just have to teach them the mindset to face it.



Chapter 19 – Every Lesson Tells a Story

Looking back, I realize that every lesson I ever taught left a mark on me and on my students. It's the small details that connect the pieces of a larger story, fragments of a journey that has been built one classroom at a time. Each class became like a chapter in a book, carrying its own challenges, laughter, and surprises.

What makes these moments powerful is that they tell not only my story, but the stories of my students as well. A competition that seemed small at first ended up uniting an entire group into one team. Even something as simple as a blinking LED lit up a child's face in a way that words could never capture. These are not just technical exercises; they are memories that shape confidence, resilience, and creativity. And that is the real treasure of robotics education. The best projects are rarely the ones that worked flawlessly they are the ones that changed someone along the way, leaving behind sparks that continue to shine long after the robot is packed away. Robotics is full of stories worth telling, and every moment holds one.



Chapter 20 – Projects that Shaped Us

MIT App Inventor Creations

One of the most empowering projects for students was building apps through MIT App Inventor, a free and visual platform that let them design real tools on their phones. The goal was simple: show them that they didn't need to be professional coders to create apps that could control robots, lights, or even track daily habits. For many, it was the first time they realized their phone could be more than just a place for games and social media it could be something they programmed themselves. With laptops, an Android phone, and a Bluetooth module linked to Arduino or Raspberry Pi, students quickly discovered how simple blocks of code could trigger motors, turn LEDs on and off, or send a robot car forward with the press of a virtual button. The magic came not only from watching the robot respond instantly to their app, but also from customizing the design with colors, icons, and sounds. Suddenly, they weren't just users of technology they were creators.

The process itself was straightforward yet exciting. We started by opening a new project in MIT App Inventor and dragging buttons and labels onto the screen. Then, step by step, students connected the visual blocks behind each button to send Bluetooth commands. On the Arduino side, we uploaded short sketches to interpret those signals and move motors. The first time a student pressed "Forward" on their phone and saw the robot roll across the desk, the classroom filled with laughter and cheers. As projects grew, some added sliders for speed control, others designed games that interacted with sensors, and a few even made apps to monitor temperature or light. This project proved that app development doesn't have to be intimidating. With the right tools and a little imagination, even a beginner could create something that felt powerful, practical, and deeply personal.

The Blue Bright Sea

The ship project began with a question: how can robotics and design help solve real environmental problems? Inspired by the growing issue of plastic waste in the sea, my students and I set out to design a small vessel capable of moving through water and collecting floating trash. The goal wasn't to clean the entire ocean it was to give students a hands-on way of thinking about engineering for sustainability. Using Tinkercad, we sketched the hull of the boat and a basket-like compartment where the trash would gather. The pieces were printed on our 3D printer and then assembled with simple adhesives. To keep the boat stable, we attached empty plastic bottles to the sides as floatation devices, proving that recycled materials could become part of the design. Students loved the fact that their boat had a clear mission: it wasn't just a toy, it was a machine with purpose.

Electronics brought the design to life. Waterproof motors and propellers were mounted on the rear, controlled by an Arduino powered by a small battery pack. With just a few lines of code, we programmed forward and backward motion, and soon the boat was ready for testing. The moment we placed it in water, students gathered around with anticipation. It didn't move perfectly straight, and sometimes waves pushed it off course, but that was part of the learning curve. Each test encouraged them to think like engineers: how could they balance weight, reduce drag, or improve steering? Some even experimented with nets or mesh baskets to catch smaller pieces of debris. In the end, the ship became more than a robotics project; it was a statement about how technology can be fun and still carry responsibility toward the world we live in.

Delivery Drones From Scratch

This project pushed students to explore a level of engineering they had never experienced before: building their own motors with copper wire and magnets. While most drone kits arrive with ready-to-use brushless motors, I wanted to demystify the process and show how those motors are actually constructed. Starting with a simple drone frame, we carefully wound coils of copper wire around metal cores, ensuring each turn was tight and consistent. Then, using neodymium magnets arranged in precise patterns, we formed the rotor and stator assembly. The excitement built as students realized they were creating the heart of the machine, not just assembling pre-made parts. It was slow and delicate work, but every completed motor felt like a personal achievement.

Once the motors were ready, we mounted them onto the drone frame, added propellers, and connected everything to ESCs (electronic speed controllers) linked to a flight controller. The wiring was meticulous, and safety was a constant reminder one wrong connection could burn out hours of work. But when the drone finally lifted a few centimeters off the ground for the first time, the pride in the room was overwhelming. While our drone wasn't ready to carry heavy packages across the city, the project gave students a glimpse of how delivery drones are engineered and why motor efficiency matters. It blended theory with practice, showing them electromagnetism not from a textbook but from a humming, spinning machine they built with their own hands. More importantly, it sparked conversations about the role of drones in future industries from medicine to agriculture and how even small experiments today can shape the technology of tomorrow.

SmartBin on Wheels

The idea for this project was born out of a simple question: why should people always walk to the trash can when the trash can could drive to them? We modified a standard RC car into a mobile bin that could move across a classroom or even a small stadium, picking up waste along the way. The students quickly named it the “SmartBin,” and it became a mix of fun and practicality. With an Arduino, a motor driver, and a Bluetooth module, they could steer the car using a smartphone, while a small plastic bin mounted on top served as the container for trash. The design was quirky but effective a rolling reminder that robotics can solve even the most ordinary problems in creative ways.

The building process was straightforward but rewarding. Students mounted the bin securely on the chassis, making sure the weight didn't tip the car forward, then programmed the Arduino to accept Bluetooth commands. Testing was the highlight: as the SmartBin rolled from desk to desk collecting candy wrappers, the classroom turned into a playful competition over who could score the next “throw.” It wasn't just a funny gadget; it made students think about robotics in service of convenience and sustainability. Some even suggested future versions with sensors that could detect trash automatically or self-drive across corridors. What started as a humorous experiment ended as a glimpse into the possibilities of smart waste management.

The Hydroponic Garden

The hydroponic garden project introduced students to the intersection of robotics, agriculture, and environmental care. Instead of soil, plants grew in water enriched with nutrients, and the system constantly monitored pH levels to ensure healthy growth. To students, the challenge wasn't just keeping the plants alive it was about creating a system that could "talk" back to them. With sensors connected to an Arduino, the garden was programmed to send alerts whenever the pH rose too high or dipped too low, teaching them how data can drive action. It was the first time many students saw how robotics could literally feed people.

Building the system required creativity as much as technical skill. Plastic bottles and recycled containers became reservoirs, while small pumps circulated water across the roots. The pH sensor, LCD screen, and buzzer acted like a doctor for the plants, constantly checking their health. Students loved watching technology and nature blend: LEDs lit up the seedlings, pumps created gentle flows of water, and notifications made sure no plant was neglected. Over weeks, the garden became a symbol of patience and precision. Unlike robots that moved instantly, this project demanded consistency, showing students that engineering can also be about slow, sustainable growth. By the time herbs and small plants started to flourish, the classroom smelled of mint and basil proof that robotics can make science both edible and meaningful.

Beyond the Horizon

Few projects captured imagination as much as turning a normal RC car into a VR-controlled experience. The concept was futuristic: instead of looking down at a car driving across the floor, students could slip on a headset and see the world from the car's perspective. With a small ESP32-CAM mounted on the vehicle streaming live video to a phone, and the phone placed inside a VR headset, the classroom turned into a racetrack where students navigated hallways and obstacles as though they were inside the machine itself.

The build was surprisingly approachable. After attaching the camera and setting up Wi-Fi streaming, we paired it with a control app that let users steer the car while immersed in the live video feed. Testing was the real thrill students took turns driving through classrooms, dodging chairs, and laughing when they “crashed” into a table leg. The VR element turned robotics from a project into an adventure, merging physical builds with digital immersion. It also sparked bigger conversations about remote-controlled vehicles in real-world use: from search-and-rescue robots exploring dangerous areas to self-driving cars gathering live feedback. For the students, though, it was simply unforgettable a project that made them feel like they were living inside the robot.

Plastic Tracks

When students wanted to explore heavier mechanics, the RC tank project became the natural choice. Unlike cars that roll easily on wheels, tanks required tracks that could handle rougher terrain. Building them meant learning about torque, gear ratios, and balance. Each group assembled a tank chassis, fitted special motors, and programmed an Arduino to handle movement commands. As the tanks rolled across sand, grass, or even piles of books in the classroom, students saw firsthand how design decisions affected performance.

The excitement came from experimentation. Some tanks were built for speed, others for power, and a few even experimented with attaching sensors or toy cannons. Controlling them through Bluetooth or Wi-Fi modules, students engaged in mini battles, races, and obstacle challenges. But behind the fun was a deeper lesson: the mechanics of tracks and how they differ from wheels in efficiency and stability. The project sparked curiosity about real-world machines from construction bulldozers to military vehicles and gave students a chance to think about engineering solutions in contexts they'd never considered before. It wasn't just play; it was a hands-on exploration of applied mechanics.

Factory in a Box

One of the most ambitious projects was transforming simple robotic arms into a miniature factory. Using servo motors controlled by an Arduino and a PCA9685 driver, students programmed arms with grippers to pick up objects, move them along a small conveyor belt, and place them in designated areas. It was teamwork at its finest: one group coded the movement, another designed grippers with 3D printers, and others built the conveyor system from everyday materials like cardboard and rollers.

The final setup looked like a scaled-down assembly line. Objects moved from one arm to the next, each performing its task in sequence, just like in a real factory. Watching the system in action was mesmerizing a classroom full of mini-engineers seeing how automation worked at industrial scale. It also opened their eyes to the future of manufacturing, where precision and repetition are often better handled by machines. The pride on their faces when their “factory in a box” ran smoothly showed that they weren’t just learning robotics they were building a small model of the future of work.

Code Meets Canvas

Not all robotics projects involved motors and sensors; some focused on digital creativity. In this project, students learned how to design simple websites to showcase their robotics builds. Using HTML, CSS, and a little JavaScript, they created pages filled with photos, descriptions, and even embedded videos of their robots in action. For many, it was their first step into web development, and they quickly realized that presenting their work could be just as important as building it.

The process gave them ownership of their learning. They started with blank pages and ended with colorful sites that told their project stories in their own words. Some added animations, others experimented with layouts, and a few even uploaded their sites online through GitHub Pages and Netlify. This project blurred the line between robotics and digital communication, showing that engineering isn't just about building machines it's also about sharing ideas with the world. By the end, students had not only functional robots but also polished online portfolios, something they could proudly show to family, friends, and future opportunities.

The Many More Experiments

Not every project became a full chapter, but each left a mark. From obstacle-avoiding robots that raced through mazes, to smart lamps that changed color with a phone tap, to football-score counters built with sensors, the variety of experiments reflected the endless curiosity of the students. Some projects were small but unforgettable, like a light that danced with music or a robot that drew simple shapes on paper. Others were ambitious but incomplete, serving as seeds for ideas that could grow later.

What united them all was the sense of possibility. Every project, big or small, reminded students that robotics is not limited to kits or textbooks. It is an open playground where creativity, curiosity, and collaboration can lead to discoveries no one expected. These “mini” experiments may not have filled entire pages, but together they painted a picture of what makes robotics magical: the freedom to try, to fail, and to create again.

Chapter 21 – Hall of Robotics Pioneers

This is the part of the book I dedicate to my students. Every name, every school, every class is here because they are the real builders of this story. Without them, there would be no book, no lessons, no sparks of magic.

This section is more than a list. It's a tribute. To every student who held a soldering iron, who coded late into the afternoon, who failed and tried again. This is your place in history, and I'm honored to preserve it here.

طلاب مدرسة السلام في كفر قرع

| | | |
|---------------|------------------|-------------|
| احمد الظاهر | احمد مصاروة | عمر زكريا |
| لين ضعيف | محمد عاصم | محمد صوالحة |
| ايه يحيى | لين يحيى | ايمان يحيى |
| ادم عزب | حلى زيد | محمد مصاروة |
| احمد محاميد | ميار أبو عطا | يوسف هيكل |
| براء أبو واصل | لمى جريان | محمد عفانة |
| احمد علاوي | ساره يحيى | حلى ضواضة |
| بشير أبو عطاء | عبد الوكيل ميجاه | سام مسلماني |
| ملك مصاروة | فيصل زيدان | صفاء زيد |
| زينه خلف | محمد أمارة | ناهدة ملحم |
| نور طيارة | كريم أبو عطاء | |

תלמידי בית ספר עירוני יב (מקיף) ביפו

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| יונס סטל | מוהנד מוגאהד | עלי חסונה |
| גינה שקרא | מיראל | נאדין |
| מלק | קארין | לימאר אבו סלאח |
| תסנים | חדר | פוזי אבו סיעדה |
| פדל אבו קאעוד | ליאן נסאסרה | עטיה אבו נבות |
| יוסף רבו אל חיות | ג'מילה אבו נגמה | נדין אבו רמילה |
| למיס דכה | למיס באוב | סלים בסול |
| לין חטאב | ריאד חמאד | מוחמד טהא |
| דארין מוחתסב | עאידה מניעי | סירין נתשה |
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| רשיד קאסם | היאם קואס | חנאן תרתיר |
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| דרויש בכר | מוחמד דנף | יוסף זיינב |
| ג'מילה חמאד | מוחמד כתה | מוחמד לאלא |
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| עימר אבו חלווה | רמי אבו סרארי | עבדאללה איבראהים |
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| אחמד סכחפי | אחמד סעד | פיסל אבו סייף |

תלמידי בית ספר אגיאלי ביפו

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| מוחמד זין | מירה נאבלסי | למיס טוחי |
| נור חפני | מוחמד | מחמוד |
| רוקיה | שרה | יאסר |
| יוסף | רמדאן | ריאן אבו קאעוד |
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| חאלד גחלב | עדי חדאד | אמיר חרוב |
| סלימאן מוגרבי | סמיר מוגרבי | עומר מוגרבי |
| עוז אל דין סורי | דין סטל | ראגב סייף |
| מלק סקחפי | יחיה פקהא | עזאלדין קבוב |
| אדם שלש | יוסף שניר | |

طلاب مدرسة الياسمين في اللد

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| نورا الصانع | رؤيا الطوري | سلسيل الطوري |
| فاطمه جده | ايلاف زبارقه | راما زبارقه |
| ريتال مساعد | سيدانه نصاصره | مريم زبارقه |
| ادهم أبو دقه | محمد ابو عبيد | رنين ابو لبدہ |
| هيثم ابو لبدہ | بهار ابو معمر | ميرا ابو معمر. |
| علي الاعصم | محمد الاعصم. | اديب الطوري. |
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| قادي الفقير | عمر دسوقي | سيلين زبارقه |
| فارس زبارقه | منتصر زبارقه. | عوده ابو زايد. |
| طبيه ابو عبيد | انس ابو غانم. | عمر ابو لبدہ. |
| يزن الطوري | اسماء الفقير. | محمد ريشات. |
| موسی زبارقه | نورسان زبارقه. | |

תלמידי מכללת סמינר הקיבוצים תל אביב

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| דורייה אסמר | עאישה זיין אלדין | רימי רביע |
| מאיה חן גבסו | איילת אברהם | אנניה אדיסו |
| טל ממו | יעל וובגיאב | פרדו ג'לאו |
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Aybak Alabdallah - business consultant

Darin Mukhtasav- Special supporter

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