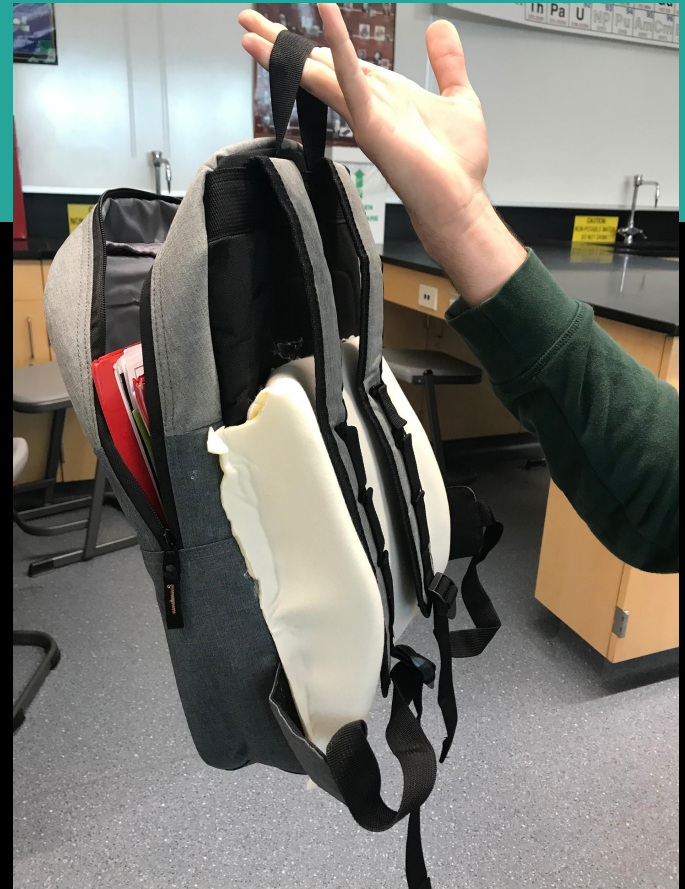


LNJ PACKS

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What is the problem?

- Almost everyone who goes to school uses a backpack, or some form of a book holder
- These backpacks put strain on backs and may create lower back pain, since many are not created to support backs, just to hold books

<https://maxliving.com/healthy-articles/backpacks-and-back-pain>



Why is this problem is important to solve?

- Back pains have increased over 100% in America in young adults over the past decade
- almost all the young adults use backpacks, which could cause or even aggravate the pains
- Modern backpacks poorly distribute weight and cause for unneeded strain in certain areas of the back
- Shoulders can become rounded due to poorly structured backpacks
- Poor backpacks cause unnatural compression of the back
- Many backpacks are inadequately cushioned for backs

<https://health.usnews.com/health-care/for-better/articles/2018-09-07/is-your-backpack-causing-unnecessary-back-pain>

<https://kidshealth.org/en/parents/backpack.html>

Who could be at risk for back pains due to backpacks?

- Anyone who uses a backpack could be at risk, but especially high school and college students who use backpacks daily and for extended periods of time.
- Teachers, professors who use backpacks
- Travelers with backpacks

<https://www.spine-health.com/conditions/lower-back-pain/back-pain-risk-factors-what-can-increase-potential-back-problems>

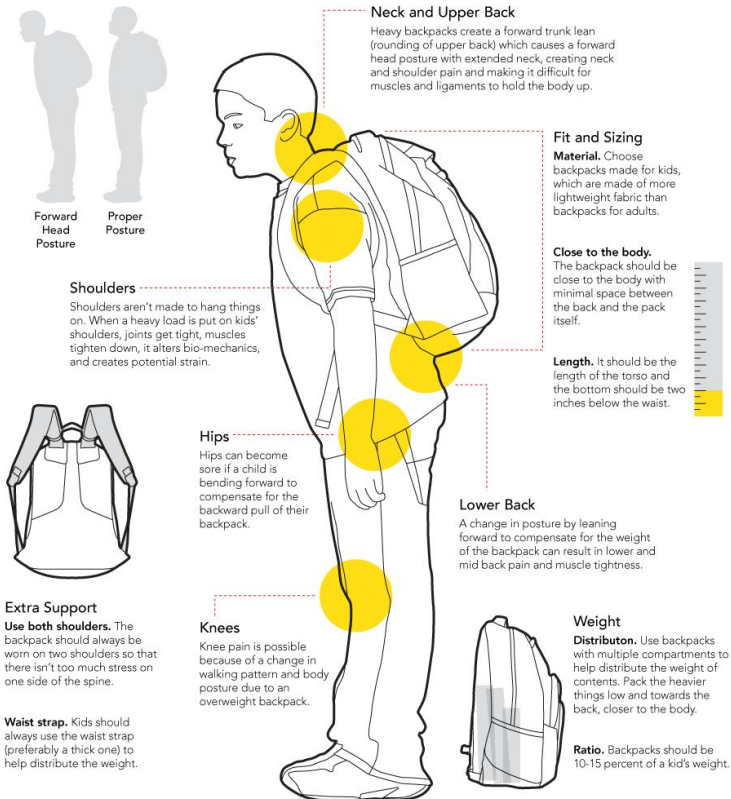
How many people the problem affects

- Back pain accounts for 264 million lost workdays per year. Many workers use backpacks.
- At any given point in time 31 million people are experiencing back pain, specifically in the lower back, which could only be worsen by poor backpacks that do not support the area

<https://www.acatoday.org/Patients/Health-Wellness-Information/Back-Pain-Facts-and-Statistics>

What Heavy Backpacks Are Doing To Kids' Bodies

About 5,000 children visit emergency rooms each year because of backpack-related injuries, and at least 14,000 kids are treated for them. While not every kid will go to the hospital because of heavy backpacks, overweight loads can cause neck, back and shoulder pain and more. Below, see what is so dangerous about kids carrying heavy backpacks — and what parents can do about it.



Neck and Upper Back

Heavy backpacks create a forward trunk lean (rounding of upper back) which causes a forward head posture with extended neck, creating neck and shoulder pain and making it difficult for muscles and ligaments to hold the body up.

Fit and Sizing

Material. Choose backpacks made for kids, which are made of more lightweight fabric than backpacks for adults.

Close to the body.

The backpack should be close to the body with minimal space between the back and the pack itself.

Length. It should be the length of the torso and the bottom should be two inches below the waist.

Forward Head Posture
Proper Posture

Shoulders

Shoulders aren't made to hang things on. When a heavy load is put on kids' shoulders, joints get tight, muscles tighten down, it alters bio-mechanics, and creates potential strain.

Hips

Hips can become sore if a child is bending forward to compensate for the backward pull of their backpack.

Lower Back

A change in posture by leaning forward to compensate for the weight of the backpack can result in lower and mid back pain and muscle tightness.

Extra Support

Use both shoulders. The backpack should always be worn on two shoulders so that there isn't too much stress on one side of the spine.

Waist strap. Kids should always use the waist strap (preferably a thick one) to help distribute the weight.

Knees

Knee pain is possible because of a change in walking pattern and body posture due to an overweight backpack.

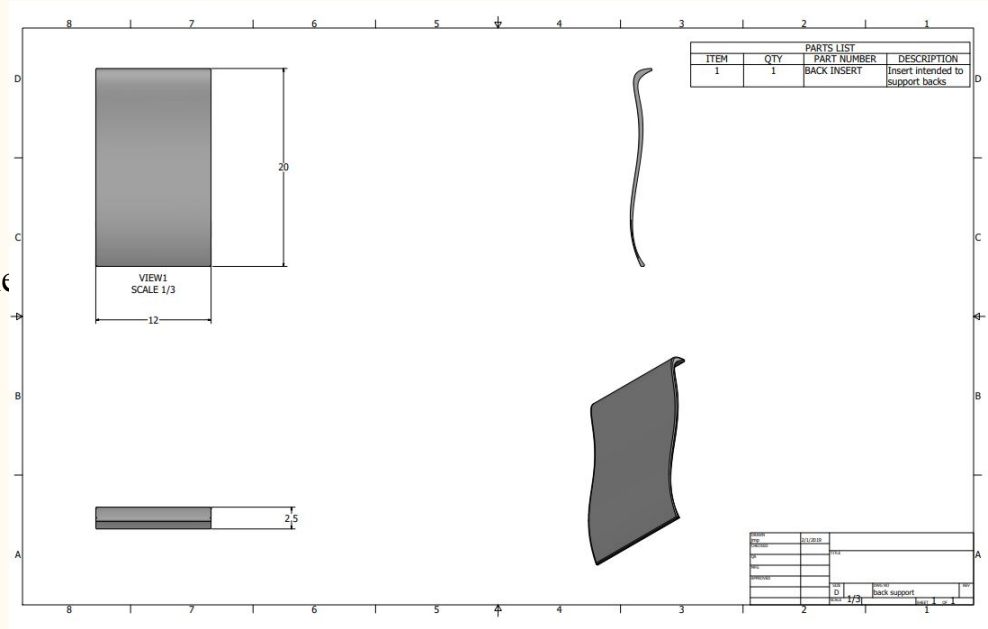
Weight

Distribution. Use backpacks with multiple compartments to help distribute the weight of contents. Pack the heavier things low and towards the back, closer to the body.

Ratio. Backpacks should be 10-15 percent of a kid's weight.

Experts and Credentials

- Consulted with Ms. Reyes (Santa Monica High School Biology Teacher)
 - kreyes@smmusd.org
- Suggested that the “hump should be raised high up due to the spinal structure and add more of natural curve”
- Told the idea was well designed and could be potentially useful for improvement of posture



Current Solutions

Rolling Backpacks



Lumbar Back Support



- Currently, there are rolling backpacks which include wheels on the bottom with a elongated handle to be able to drag the back pack on the floor without it being on your back
- There are lumbar back support devices that encourage good posture when sitting and standing
- Posture correctors are used when some people have severe back deformities and usually are effective at recorrecting one's posture

Current Solutions continued

Pros

- Rolling backpacks put no strain on your back directly
- Lumbar supports improve posture
- Some bags distribute weight equally
- Posture correctors can correct your posture very well

<https://www.spine-health.com/wellness/ergonomics/types-lumbar-support-and-ergonomic-office-chairs>

Cons

- Rolling backpacks are difficult to transport up stairs and inclined hills
- Must bend over to roll backpack
- Cannot take an efficient lumbar support with you around work, school, etc.
- Not many backpacks are made to support backs and those that are are very costly --->
- <https://theluggageprofessionals.com.au/blog/wheeled-backpacks-vs-backpacks/>

(Deluxe Full Back Posture Corrector Brace)



Hiking backpacks have better support than traditional backpacks but are very expensive (150\$+) <https://www.rei.com/c/backpacks>

What do these solutions not fully solve the problem?

- Although there are many solutions and inventions to fix the problem after the fact of its effects on your back, there are not many solutions that focus on the prevention of back pains
- Rolling backpacks create stress on the shoulder joints, due to the bent position while holding the handle.
- There are no minimalistic backpacks that evenly distribute weight

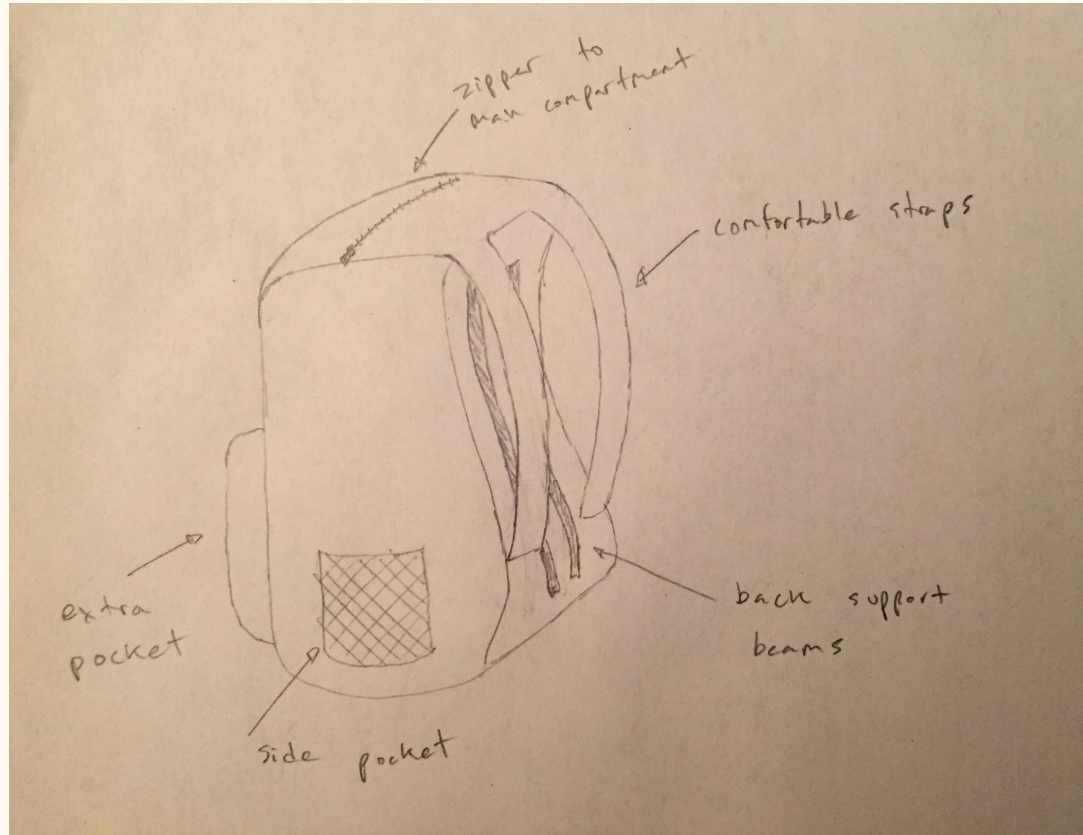


How are LNJ Packs going to fix these problems?

- LNJ Packs intends on focusing on preventative measures rather than spine correction.
- Inexpensive cost - more accessible for people to own a back-supporting backpack.
- Sleeker design and less bulky compared to hiking backpacks.



Solution to Problem



Solution to Problem

Our solution is to make a new backpack that is formed to fit with a humans natural spine. The backpack will have lumbar support to allow and maintain good posture. The backpack will also be made of mesh so that the persons back can “breathe” and avoid sweat. Along with solving the problem, It will be cheap and affordable for everyone to own.

Our group will first research different types of back supports and find the best shape to support a person’s back using the different prototypes. Next, we will take generic and cheap backpacks and replace the backs of them with our own supports. This will be a more efficient and cost effective way to accomplish this problem rather than making entirely new backpacks.

How will this be done?

- Modifying the backside of a backpack - attaching breathable mesh, along with the framework of the normal prototype of a back
- Making the framework out of a soft but sturdy material (plastic, foam, mesh)
- Adding the framework to conform to the back of a human and shape the back correctly.



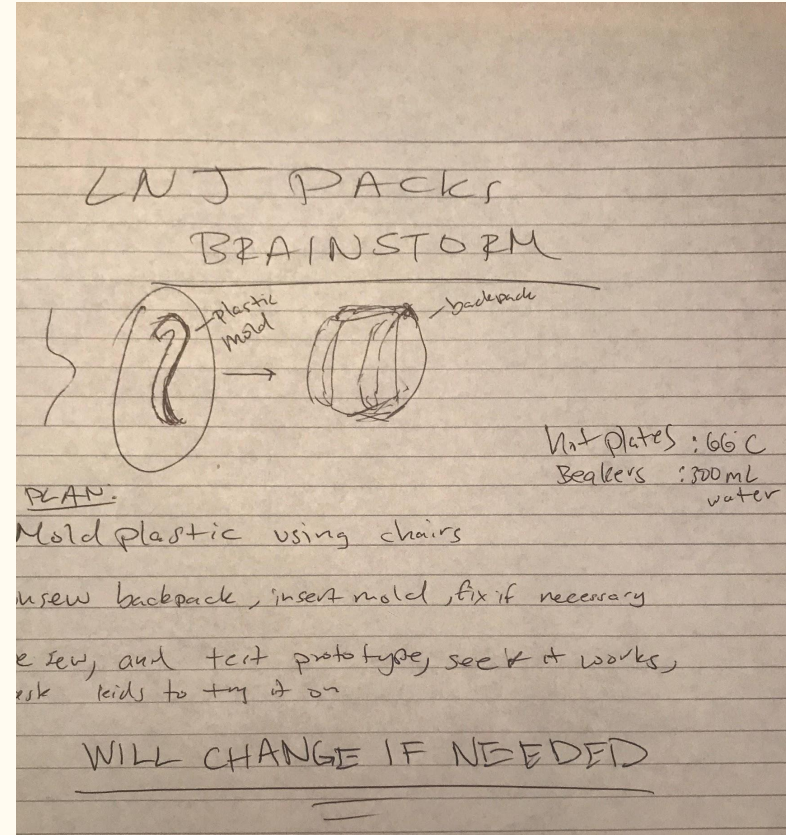
Prototype Construction

Day 1: Took a look at various back supports and lumbar supporting chairs and try to distinguish what makes them “back supporting”

We found that majority of these lumbar supports have a “hump” located where there is an indent in the spine, so we decided to create something to fill the gap but on a backpack.

(<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3766244/>)

Day 2: After the creation of our brainstorm along side the CAD file, we decided what materials we needed, and purchased them.



Prototype Construction Continued

Day 3: Tested the InstaMorph (\$16.99) moldable plastic. Tested by melting a small sample of plastic and made a smaller scale mold of the back support and let it dry. Determined malleability, durability and dry time.



Prototype Construction more continued

Day 4: Using multiple bunsen burners and the majority of the plastic, a mold was created to support backs. The mold was initially intended to be formed on a chair, but later improvised and used a team members back.



Prototype Construction

Day 5: The mold hardened and was well made, however, there were still many sharp edges and curves that we had to remove, so the band-saw was used to remove these excess parts.

Day 6: Attached the plastic to our backpack (9\$), and covered it with foam(8.99\$) and fabric (2\$). Later attached it to the backpack, and made sure it would not detach.



Final Prototype

- Created a back supporting backpack that is smooth, and comfortable
- No sharp edges
- Included designs from other back supporting backpacks.
- The entire process of creating this prototype took around ~1 week
- Overall Cost: 37\$



Testing Plan

- Created multiple tests that it had to go through to be a valid backpack
- Created a survey that asked various questions about the backpack, and asked if someone was likely to purchase and wear one
- We then planned out to ask students to wear the backpack (using random sampling to avoid confounding variables)
- We also intend on testing its durability (ex. Withstanding various drops, or other tests that other backpacks go through to be sold to the public)

Testing Plan Continued



- **First Test:** See how people like the feel of the backpack

Goal: Observe if people like the backpack, gather “first impressions”

Procedure: Allow people to use the backpack and ask them if they enjoy it.
(Comfortability, Aesthetic, Functionality)

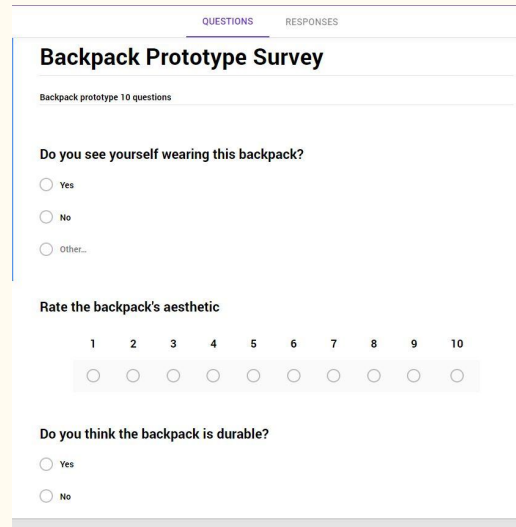
Materials Needed: Prototype of backpack

Safety Concern: If person testing backpack has/had any back pain.

- We will ask various people (representation of mass majority) to wear the backpack for a little while (few minutes) to see if they like how it feels, and take any responses they have. (Initial Reactions)

Testing Plans Continued

- **Second Test:** Examine the results of the survey and locate where it can be improved.
- **Goal:** See if there's anything we should improve about our backpack using the surveys.

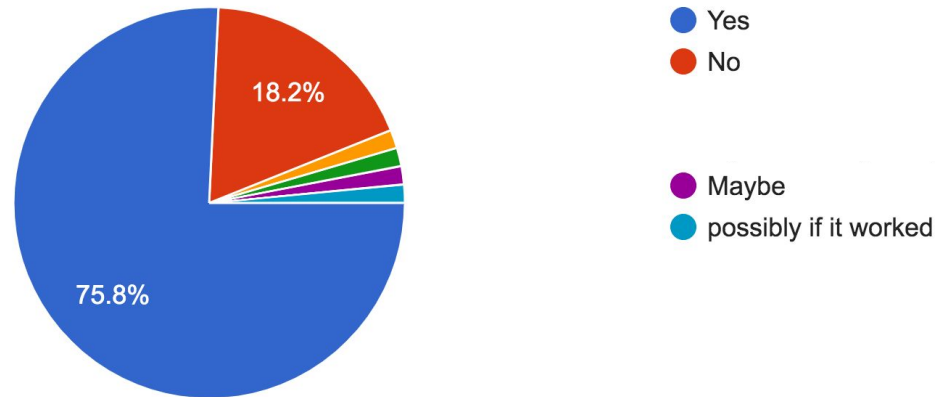


The image shows a screenshot of a survey interface. At the top, there are two tabs: 'QUESTIONS' (active) and 'RESPONSES'. The survey title is 'Backpack Prototype Survey'. Below the title, it says 'Backpack prototype 10 questions'. The first question is 'Do you see yourself wearing this backpack?' with three radio button options: 'Yes', 'No', and 'Other...'. The second question is 'Rate the backpack's aesthetic' with a horizontal scale from 1 to 10, each with a radio button. The third question is 'Do you think the backpack is durable?' with two radio button options: 'Yes' and 'No'.

Survey Results

Do you see yourself wearing this backpack?

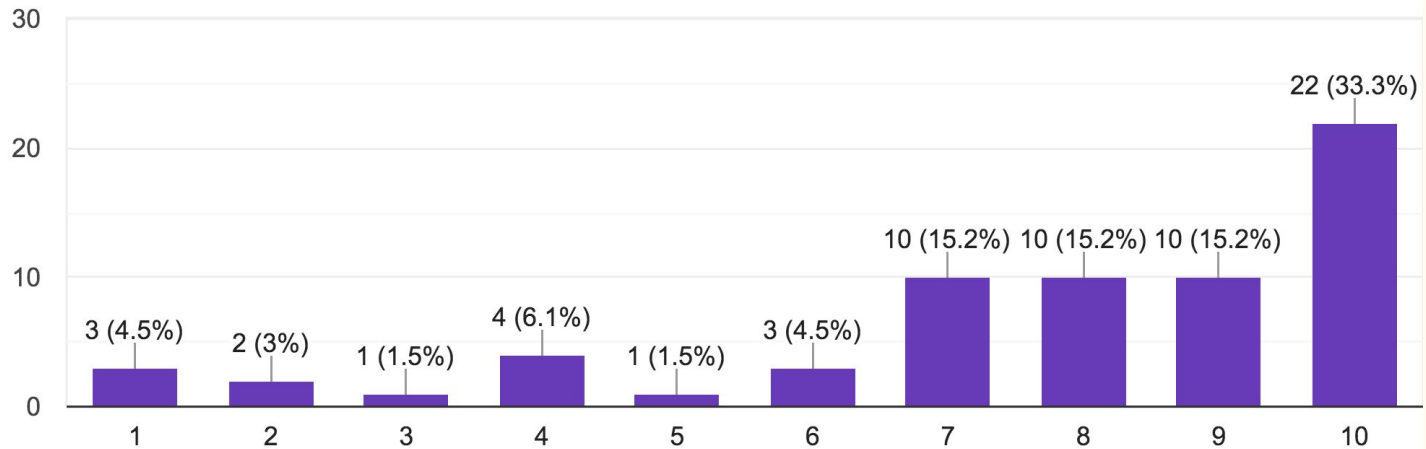
66 responses



Survey Result

Rate the backpack's aesthetic

66 responses



Testing Plans Continued



- **Third Test:** Test durability of backpack

Goal: Backpack will withstand pulling, drops and natural elements

Procedure: Be rough with backpack and see how much wear and tear it can take.

Materials Needed: Prototype of backpack

Safety Concern: Someone being injured while being rough with the backpack

Sample of Testing Results (Initial exposure to new backpack)

Name, Grade, Age	Did product work?	Improvements
Chikara, Senior, 18	“This is actually pretty good and it supports my back well”	Not enough space More comfortable straps, add padding
Tia, Freshman, 15	“It’s alright, I guess”	N/A
Jacob, Senior, 18	“It’s lowkey comfortable bro”	Mesh to reduce sweat Padding was a little irritating

Analysis of Test Results

- There are not many results currently, but as seen from the initial impressions, the overall idea of the backpack is positive, but there is room for improvement
- Backpack is rather durable, as it's been dropped from 6 feet with books inside of it and had no obvious damage, and the lumbar support did not come loose

What do our stakeholders have to say?

- Breanna Snyder, Chemistry/PLTW Teacher: This is a decent backpack, it's not bad, but you guys could have done better .

Analysis: Ask her what the specific problem with it is and improve based on that

- Shrayes, LNJ Pack tester: It's very inventive, but I don't like the color

Analysis: Great!

What's Next for LNJ Packs?



- Add two straps on the sides (across the chest) to increase support and further distribution of weight more efficiently
- If money was not a limiting factor, a sewing machine would be used to sew the backpack, and a 3D printer to create the backmold from CAD, and not someone's back.

LNJ

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