

Category 3 Inventions

Written Report

Title of Project: The BagWagon
Group Name/Number: The B.A.G project / 03-34
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1. Problem Finding

1 A

Starting from the theme of “inconveniences in students lives”, we came up with the following problems. This theme was chosen as it is very relevant to us.

- Troublesome to wash items before recycling them
- Heavy bags that affect students’ health
- Wet umbrellas taking too long to dry
- Tangled earphones
- Troublesome to keep loose change

In the end, we narrowed it down to consider heavy bags, wet umbrellas and loose change based on the following:

- Feasibility: Is it realistic?
- Prominence: How widespread is the problem?
- Magnitude: How severe are the impacts of the problem?
- Originality: How creative can it be?
- Urgency: Is there an immediate need to solve the problem?

1 B

Problem Evaluation Grid

Considerations for Selection	Problems		
	Troublesome to search through loose change	Umbrellas lacking a proper way to dry	Schoolbags are too heavy
Feasibility in Solving Problem	2	4	4
Magnitude of Problem	2	2	3
Originality of Possible Solutions to Problem	3	2	3
Urgency of Problem	1	2	3
Prominence of Problem	4	4	3
Total Score (max. 20)	12	14	16

2. Define the Problem

2A

Students and adults both have to carry heavy bags, sometimes almost daily. This puts an unhealthy amount of weight on their back.

- An article from The Straits Times (Yap, E. & Yap, K., 2014) suggests that heavy bags are unsuitable for young students. Physiologists also link heavy school bags to backache in children. According to a study in Saudi Arabia (Al-Hashem M. H. et al, 2016), 72.46% of students carry bags weighing at least 15% more than their body weight. Over 42% reported back pain.

ii. Adults who work in fields such as engineering have to carry heavy tools in their bag as well. This is especially dangerous to older adults who have weaker bones that sustain damage easily. The Scientific American found that 9% of older adults have osteoporosis, higher than in any other age group.

iii. Survey involving 54 students (Primary 5 to Secondary 4) was carried out:

63% claimed that their bags were heavy/very heavy.

Over 87% attributed this to unavoidable circumstances e.g books for lessons.

79% expressed interest in product which alleviates burden of carrying heavy bags.

2 B

Roller bags



- Advantages
 - + Can easily switch between pulling bag on wheels and carrying it on the back
 - +Large capacity
 - +Wheels are durable
- Disadvantages
 - Handle is dense, making the bag bulky
 - Wheels attached to the bottom makes it uncomfortable to carry on one's back

Accordion Folders



- Advantages:
 - +Good capacity yet compact
 - +Helps with organisation
 - +Can be handheld, making it lighter
- Disadvantages:
 - If it's handheld, can be troublesome
 - The file has a storage limit
 - User has to support its weight with their hands

Retractable folding trolley



- Advantages
 - +Compatible with a variety of luggages
 - +Able to carry and hold luggages of different sizes and weight
 - +Durable
- Disadvantages
 - Bulky and adds onto weight of the luggage
 - Difficult to store when not in use

3. Your BIG IDEA

3 A

- A kit that includes a pair of wheels that are easily attachable to school bags, and an attachable handle to wheel the bag around.
- It is made up of two parts: Adjustable handle and detachable wheels

3 B

- Alleviates the stress of heavy bags on students
- Provides convenience when they have a large bag to carry over long distances
- Reduces likelihood of students suffering from long-term health issues

3 C

- Customizability: handle and wheels can be attached to any bag
- Durable wheels
- Lightweight handle

3 D

- Sourcing for materials
 - Some specific materials that are necessary may be difficult to obtain
- Testing out certain traits of the product
 - Lightweight: This may be difficult to quantify since heavy/light may be subjective
 - Durable: Difficult to test how durable an object is in the short amount of time span
- Finding students to partake in pilot testing
 - Students may find that carrying bags on their shoulders is not a burden
- Challenges in assembling the invention
 - Making the invention detachable yet securely fastened will not be easy

3 E

- Construction of prototype ver.1 (T2W8-T2W10)
 - Ver.1 is a crude model of the product made from cardboard materials etc. to plan the schematics and outline, and determine feasibility of concept i.e Platform + Handle
 - Results
 - Sew-on velcro→ Not customisable (has to be sewn onto surfaces of the bag)
 - Rope→ Not aesthetically-pleasing, tangles easily
 - Magnetism→ Simple to use, important to balance the strength of the magnets (If too strong, difficult to separate the bag from the platform, if too weak, bag may not be properly attached to the platform, which causes the device to fall apart)
- Construction of prototype ver.2 (June Hols- T3)
 - Ver.2 is the actual product
 - Used to determine if we can add on additional functions e.g platform-supporting pole, integrating elastic string as part of the handle etc.
 - Additional features include:
 - **Handle with adjustable lengths**
 - Elastic string attached to a small cap, and inserted through the plastic tube.
 - **Two-part support system**
 - Below the platform, consisting of a thin rod coupled with a slightly thicker rod
 - By stabilising the platform, the tubes make it more convenient for usage on the go
 - **Removed centre-piece concept** i.e hinge between the 2 platform pieces
 - Unsuitable for the acrylic board we have used (drills and screws would have to be used to install the hinges which would cause the board to crack)

- Pilot test I (Start of T3)
- 5-10 students will be given product ver2.0 for a specified period of time. After using the product, surveys will be given out to collect opinions and comments in order to determine how useful our product is realistically compared to our proposed advantages
- Time: 1 school day for each pilot tester (Coming to school **and** going back)
- Procedure
- They will get to use the product as and when they like
- After the period of usage, we gathered comments on the design and practical usage
- Based on the comments and AFIs, we will implement changes and improvements
- Make a comparison on convenience and practicality of product based on theory

4. Construction

4 A

Prototype ver.1

- Mainly cardboard
- Easy to obtain
- Easy to cut through to produce a desired shape
- Able to make changes as necessary for various reasons
 - Aesthetic, Functionality
- Accentuates the general shape and outline of our product
- Serves as a basis for final product as well as referencing

Final product

- Board and wheels:
 - Acrylic
- Lightweight, Extremely durable
- Easy access
 - Small wheels
- Retractable handle (T-shaped)
 - Material: Plastic tube (1.80mm x 650mm)
- Body of the handle
- Lightweight, Durable
 - Material: Two wooden sticks
- Grip for the handle
 - Material: Twine
- Threads through the plastic tube
 - Replaced with elastic string
- Gives some allowance/buffer length for the user to stretch the string etc.

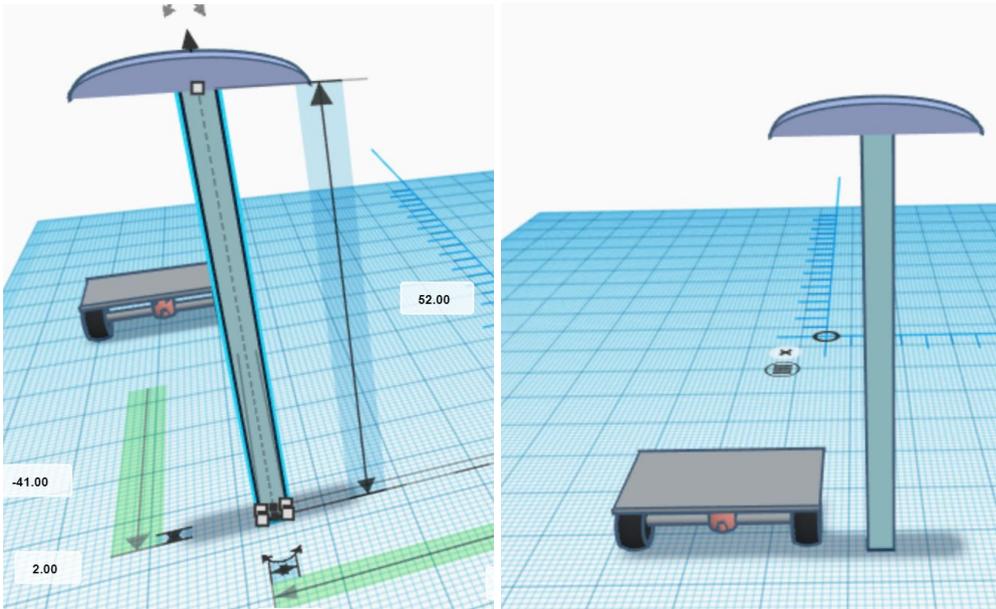
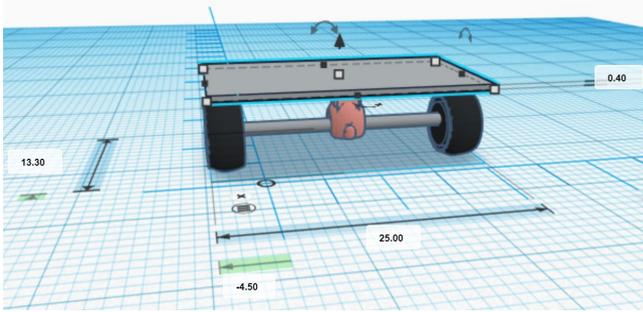
4 B

- Cost
- Acrylic Board: \$10.00, 4 wheels: \$6.00, Plastic Tube : \$2.00
- Total Cost : \$18.00

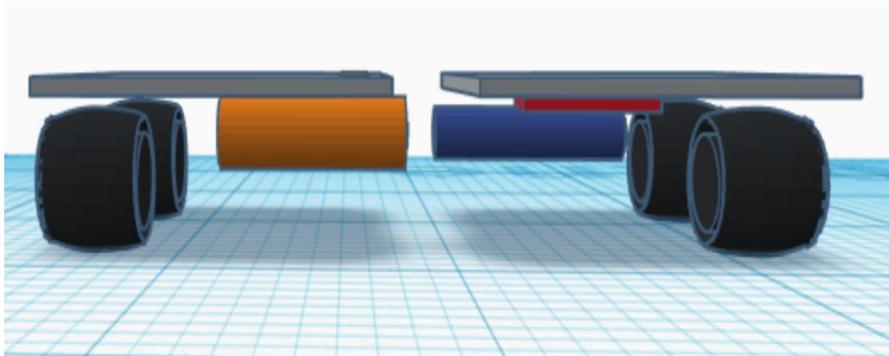
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- Measurements (of final product)
 - Base of platform 25.0cm x 13.3cm x 0.6cm
 - Handle Length → 45cm
 - Wheels Radius → 25mm

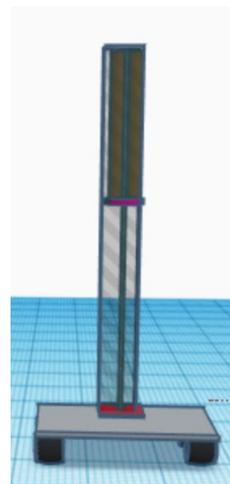
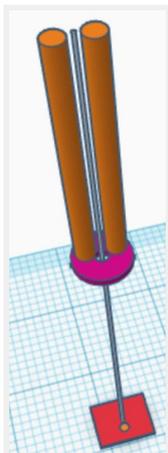
- Virtual model
- Pre-proposal evaluation (Initial idea-forming)



- Post-Semis evaluation (Improvements made after Pilot test 1)

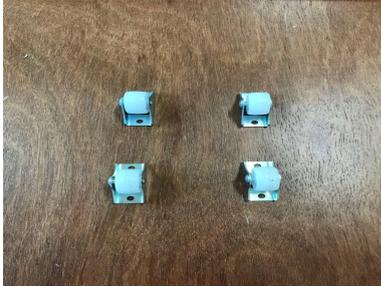


- Two-part support system

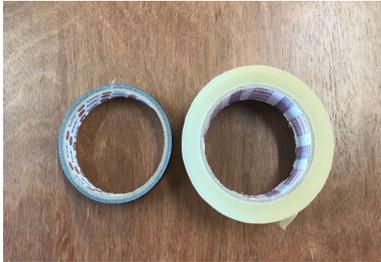


- Retractable handle with adjustable lengths

- Developing the product
- Prototype ver 1.0
- Materials:



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- Plastic wheels of diameter 25mm (Lightweight and durable)



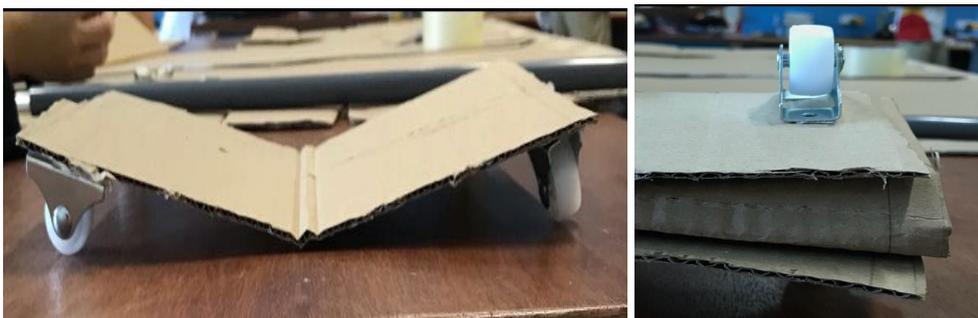
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- Masking Tape



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- Plastic tube (Used initially for the handle)
- Testing new ideas and capabilities

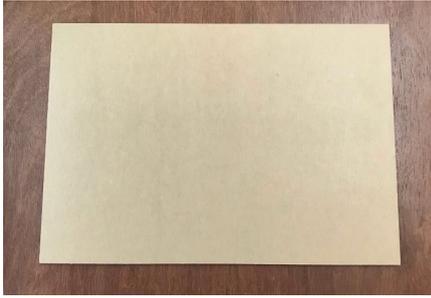


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- Trying out different wheel arrangements to make more compact for storage



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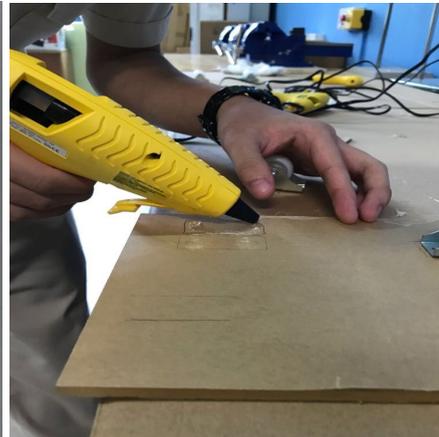
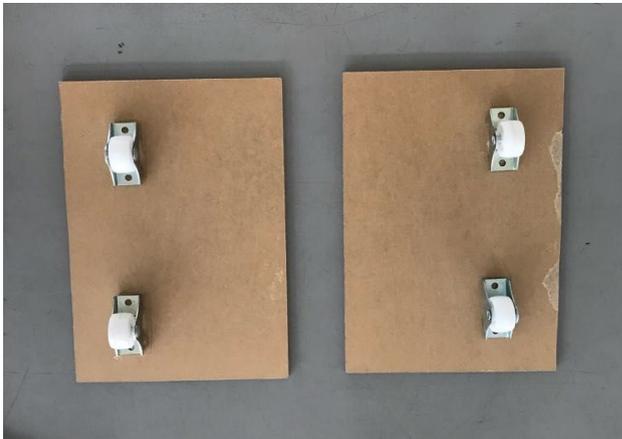
- Starting on actual product



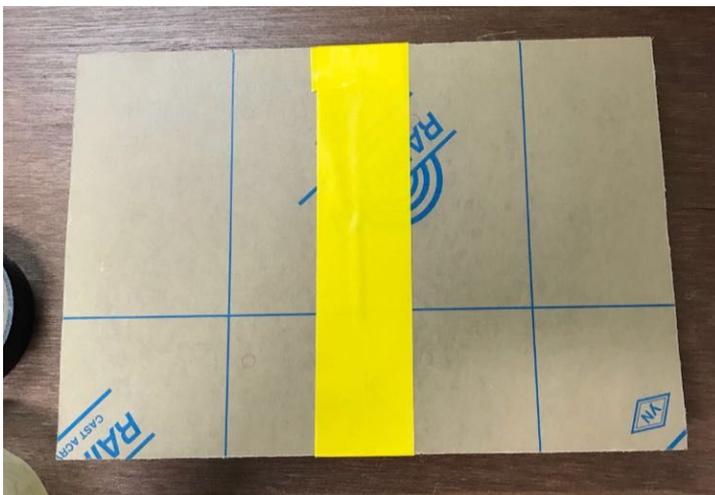
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- Using a 30cm x 21cm x 0.5cm (L x B x W) acrylic board for the platform



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- Plastic string (instead of the previously-used yarn) for the handle



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- Using hot glue in order to attach the wheels to the base of the platform



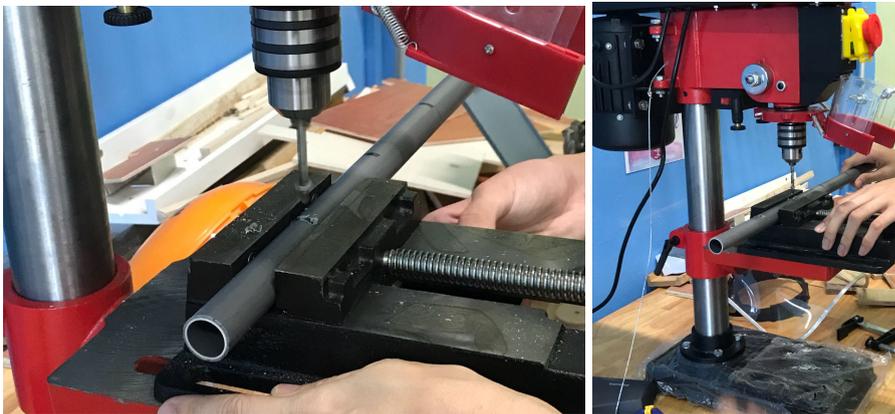
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- Using masking tape to simulate the role of hinge that connects 2 pieces of the platform
- Improving on the prototype with comments from **Pilot Test 1** and **Proposal/Semis**

Evaluation

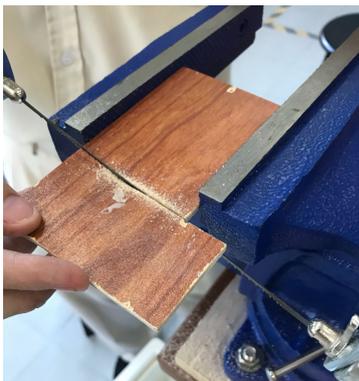
- Switching to a larger plastic tube (for user convenience)



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- Measuring and cutting the plastic tube (for making the handle)

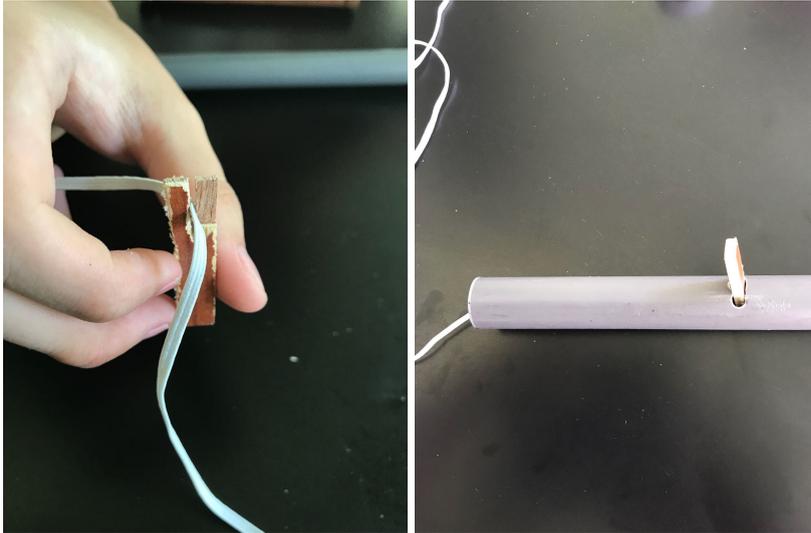


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- Using the bench drill to create slits in the tube (this is to create the “key” system which will make handle adjustable at different lengths)

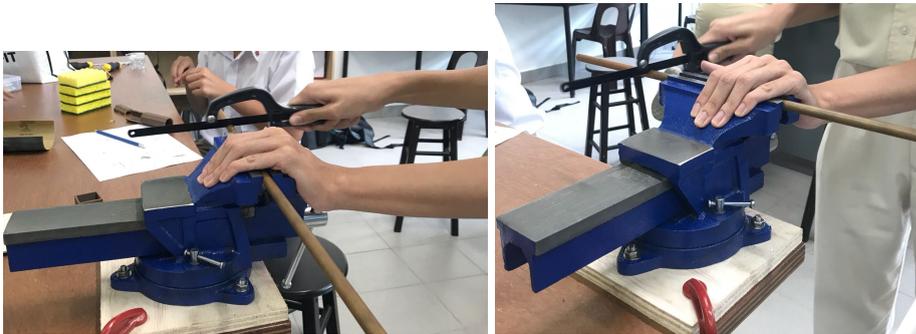


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- From a piece of wood, we sawed the “key” out and made a tiny indent, jaw-like feature at one end, such that when the elastic string is placed through the tube, the user may simply clamp the elastic string between the “jaw” and the wall of the tube to keep the handle at that specific height

- This is an example of the “key” we will use for the handle



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- The “key” will catch the string in between its “jaws”, through the slits made at different heights which will allow the height of the handle to be adjustable



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- Sawing the metal tubes that will form our two-part support system



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- The smaller and larger metal tubes link up. When attached to our platform, it ensures that when the device is pulled forward, the two pieces of the platform will stay together to support the weight of the bag

5. Modification and Evaluation

Test Iteration: Pilot test (ver 1.0)	Tick			Remarks
	Pass	Fail	Potential Failure	
Test Date: 2/7/18 - 6/7/18				-NIL-
Test Criteria 1 Does it meet its aim (Durable, cheap, customisable, convenience on-the-go etc.)	✓			<p>Pilot testers noted that the total cost of \$20.00 might be out of their price range (since our target audience is students), thus we would have to work towards construction with cheaper materials</p> <p>There were generally positive comments on customizability, which several testers felt had been the main selling point of our product.</p> <p>It was slightly more difficult to gauge durability in the long term since the period of the pilot test only lasted one school day per person (approx. 1 trip to and from school).</p> <p>However, we noted that there was not much damage <u>or</u> wear-and-tear on the product</p>
Test Criteria 2 Ease of Usage		✓		<p>Testers were generally confused about how the device (especially the handle) worked and demonstrations were needed. Even though the concept itself is simple, the actual design of the product may be confusing/complicated which complicates practical usage.</p> <p>They also cited that setting up the product to use can be troublesome, if they are in a hurry.</p> <p>Based on concerns raised e.g “the string in the handle is too short”, “the grip is too thin to be used easily” we plan to improve on the current features but also to implement newer features</p>
Test Criteria 3 Compactness	✓			<p>The size of the device is already quite small, coupled with the foldability feature (masking tape to simulate a hinge) meant that the device could be stored in a school bag simply.</p> <p>However, there were also comments of the plastic tube being too long to fit, meaning that users had to hand-carry it</p>

We have removed the hinge feature in favour of the two-part support system. After implementing the necessary changes to our product, we conducted another round of pilot testing. With the same parameters as Pilot test 1, we gathered comments and suggestions on how the product has improved and how it can be better i.e **AFIs**

Test Iteration: Pilot test (Product ver 2.0)	Tick			Remarks
Test Date: 20/7/18 - 28/7/18	Pass	Fail	Potential Failure	-NIL-
Test Criteria 1 Does it meet its aim (Durable, cheap, customisable, convenience)				<p>Users were generally attracted to the product due to its unique customizability feature.</p> <p>We had substituted several of our component parts with cheaper materials, allowing us to lower. (From \$20.00 to \$16.50 for the materials)</p> <p>Since there were fewer participants, each pilot tester was also able to keep the device for personal usage for a longer period of time. After around a week of continuous usage, there was no wear-and-tear to the wheels. The pipes forming the two-part support system did not fall out.</p>
Test Criteria 2 Ease of Usage	✓			<p>With, the improved design, users noted that it was a lot easier to carry around as compared to how flimsy the platform was when only masking tape had been used. We made improvements to the handle as well (the handle in ver 1.0 had the thickness of a standard pair of chopsticks, which meant that it was too thin to grip during usage) using thicker wooden rods that were easier to hold onto</p> <p>The addition of the adjustable handle was also appreciated by pilot testers as they had felt that it was more comfortable to use the device when they were in control of the height of the handle.</p>
Test Criteria 3 Compactness			✓	<p>In removing the foldable feature, it has become slightly more difficult to place the device for storage. This is because, there are several external features that may be dislodged from the product. For example, the wheels on the underside of the platform can be easily dislodged, such as when the device is dropped or when a large force is applied on it. In fact, nearing the end of the period of usage (for pilot testers), the pipes of the two-part support system had already slightly fallen off. Testers also felt that those particular components seemed fragile and preferred to store the device in compartments of the bag that were more spacious. This adversely affects compactness since we had hoped for the device to be able to be stored in small and tight spaces (which is typical of full school bags)</p>

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