

NATIONAL DESIGN PROJECT



Our Project Title: DM² (read as “D-M-squared”)

DM² is an all-in-one magnetic duster that provides space for magnets and markers, that even comes with a cover!

Our Team Name: The Brainiacs

Our Team Members:

Huang Zetian

Jiang Haocheng Jason

Ng Tei Ern, Jeriel

Ng Xing Yu, Sebastian

Henry Park Primary School

Name of Teacher IC: Mdm Ong Li Ling

Email of Teacher IC: ong_li_ling@moe.edu.sg

Contact Number: 6466 3600



I. Project Overview

Mrs Goh's encounter

Mrs Goh walked into a classroom expecting to be able to use the whiteboard accessories (markers, dusters and magnets) in the classroom. To her dismay, the markers had run out of ink, and the duster was nowhere to be found. She hurried to the next classroom and asked for whiteboard accessories but found out that they were facing the exact same problem. She visited the next class, but they had no extra markers to spare.

In the end, Mrs Goh had no choice but to return to the General Office for replacements. When she returned, 15 minutes had passed. Halfway through her lesson, she needed some magnets and had to dig in her bag to hunt for them. She also moved back and forth across the classroom to gain access to the whiteboard accessories. As she had to hurry through her lesson to make up for the 15 minutes lost, there were several occasions where her duster accidentally fell to the ground, as the ledge beneath the whiteboard was too narrow. The fallen duster also left a large area of dirty dust marks on the floor.

When the lesson was over, she hurried to wipe the whiteboard, pack up the magnets and markers, throwing them haphazardly into her bag so as to bring them along with her to her next class. She was worried that she may encounter the same problem in the next classroom she entered.

Current Situation:

On a typical school day, there are at least five teachers who walk into our class for different lessons. They will usually bring along their own markers and magnets with them into the classroom. When using the whiteboard, they have to walk back and forth across the classroom to get these items as they are placed at different parts of the room. At times, in their hurry to move on to other classes, they leave their markers behind. They also sometimes have trouble locating them within their bags, delaying lesson time. In some special rooms, for instance the Art or Music room, teachers who rely on whiteboard accessories in the class may not be able to locate the whiteboard accessories and have to go to other classes to borrow some, wasting precious time.

Teachers also find the dusters in the classroom dirty. When using the duster, it often falls off the ledge and teachers find it a hassle to pick it up while teaching. It also disrupts the teacher's train of thought and disrupts the lesson. We commonly see the dirt that falls off dirty dusters on the classroom floor or left on the whiteboard ledge. However, we also realise that the classroom duster frequently goes missing from our class, possibly borrowed by other classes who forgot to return afterward.

After much consideration, we discussed and decided to work on how we might combine the whiteboard accessories together for convenience and ease of use by teachers and ensure that it is not overly bulky or troublesome to pack up. We also hoped to design a solution to enable teachers to bring along their own duster without worrying about dirtying their own bags or worksheets, and to avoid entering classrooms unprepared.



II. Research Findings

We surveyed a total of 90 teachers and lecturers in MOE Primary, Secondary, Junior Colleges as well as Polytechnics. Our survey aims to find out their struggles, needs and how our suggested solution might be beneficial to them. Through the survey, we found that the majority of the teachers (90%) preferred to bring their own whiteboard accessories to classrooms.

Among those who bring their own whiteboard accessories, almost half (48.1%) felt that it is too troublesome when they need to pack up after each class. 76.5% of the respondents have lost some of their items as they left the items behind by accident.

All the teachers who choose to use shared whiteboard accessories have experienced lost and dirty dusters, missing markers and markers that have run out of ink. 88.9% of them wished that they had their own set of whiteboard accessories at that point.

Several teachers expressed the need for a secure cover on the duster, to prevent dust from the duster from falling into their bags if they were to bring it along to the next class in their bags. There were also suggestions to include a hand strap. The need to be “compact” and “lightweight” are commonly mentioned in the responses. Teachers also appreciate the convenience of locating the markers and magnets with the duster.

Full details of the survey responses can be found in the **Annex** below.

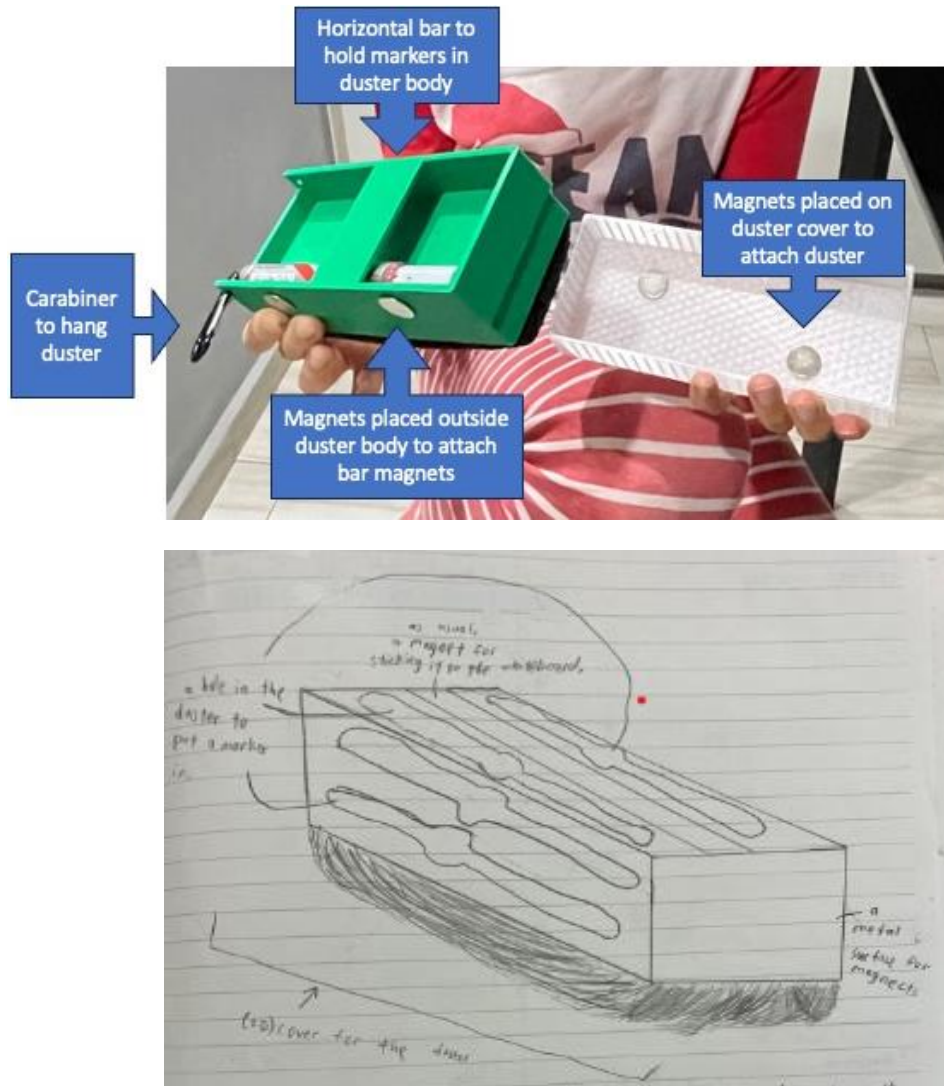
III. Proposed Solution

Based on our daily classroom observations, we decided to come up with an all-in-one design that accommodates markers and magnets on a magnetic duster with a cover, allowing teachers to access whiteboard accessories conveniently without wasting too much time and having to walk repeatedly from the whiteboard to their bag/desk, just to take a marker of another colour or look for magnets.

The prototype is designed to be the same size as ordinary dusters used by teachers in the classroom. We gathered this is probably an optimal size for us to work with since most of the school dusters are that size.

We have designed the use of space such that the markers and magnets behind the duster so the teacher can have easy access to all the essential accessories. Unlike typical magnetic dusters, whose magnets are located at the back/side, we have placed neodymium (strong rare earth) magnets under the eraser part of the duster. This makes it convenient for teachers, as they can wipe the board and leave it stuck to the whiteboard for quick access later on. The marker and magnets can also be easily taken out from the back during lessons when needed.

Here is a picture of our first prototype and drawing:



We originally designed the prototype with a horizontal plastic bar over the slot for markers. However, we discovered that it made rattling sounds whenever teachers wiped the whiteboard as the markers could freely move about within the space.

We also thought of including a carabiner to make it more convenient for teachers to clip it onto their bags when moving from class to class. However, it similarly made loud noises whenever it moved against the body of the prototype.

As we did not have metallic strips initially, we tried to paste magnets on the prototype, to attach bar magnets and the duster cover. However, we realised that placing bar magnets on the outer sides of the prototype can interfere with the ease of use of the duster. Duster dust can also accumulate around the magnets within the duster cover and it might be inconvenient to wipe clean.

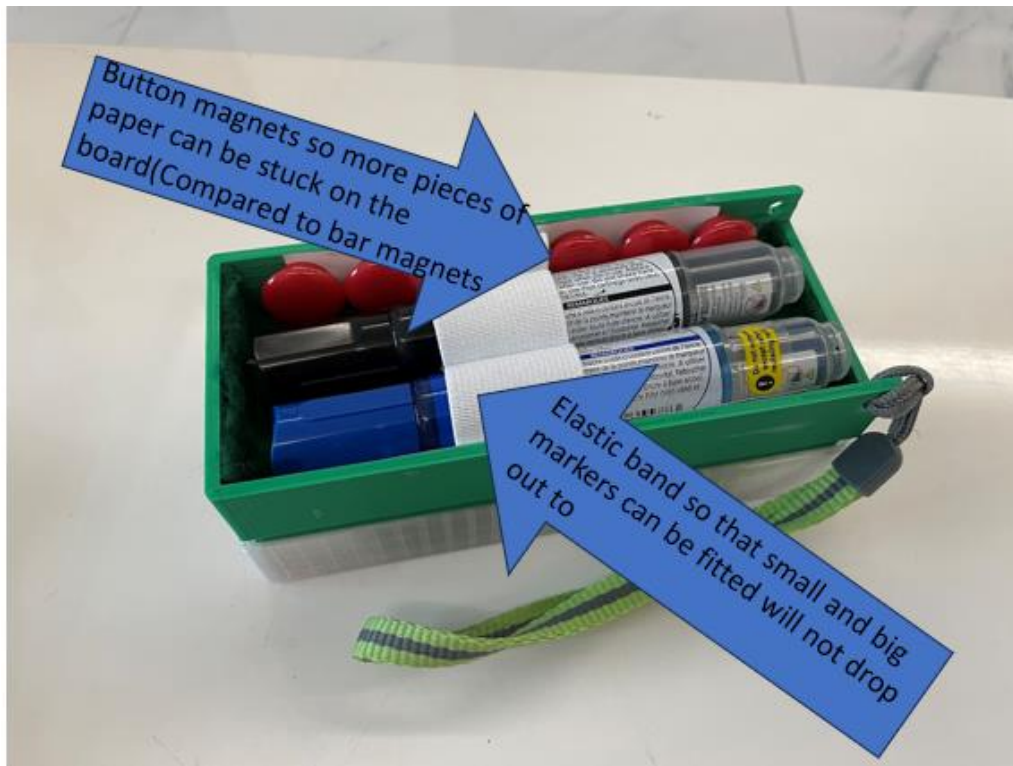
Here is the picture of our second prototype:



In our second prototype, we shifted the position of the bar magnets to be on the inside walls of the marker holder. We pasted metallic bars instead of magnets on the walls, to attach the magnets, as the attraction will be better (no repulsion between the magnets). We also tried to line the marker holder portion with felt (not shown in photo), to reduce the rattling noises of the markers when wiping the board with the duster. The carabiner was also removed to reduce the noise it made during movements.



Here is the picture of our third and final prototype:



In our final prototype design, we removed the horizontal bar and used elastic bands to secure the markers in place to ensure that they would not fall out easily and would not make rattling noises (*see section IV "3-D printed prototype with explanation of the various design functions"*). The elastic bands also cater to different teachers' preferences, as they will be able to accommodate 2 to 3 markers of different sizes, big and small.

To streamline the design and maximise the space within the marker holder, flat metal strips are pasted on the internal side walls for teachers to securely attach magnets of varying shapes and sizes that they need (*see section IV "3-D printed prototype with explanation of the various design functions"*). This helps to prevent the magnets from being lost in their bags and enable them to reach for it easily when they need any. The long metallic strip also caters to teachers' preferences as they can choose to attach either up to 4 bar magnets or 7 round button magnets to the strips.

We replaced the magnets on the duster cover with thin metallic strips (*see section IV "internal assembly of duster cover"*). A thin removable plastic layer is placed over the metallic strips and can be easily wiped clean of duster dust if needed. This will address the main concern from our respondents, to ensure dust from the eraser portion does not fall out into the teachers' bags or dirty their worksheets when it is being brought from class to class. It is also easy yet secure to remove and reattach the duster cover, as we have placed strong rare-earth neodymium magnets in the duster that is much stronger than ordinary



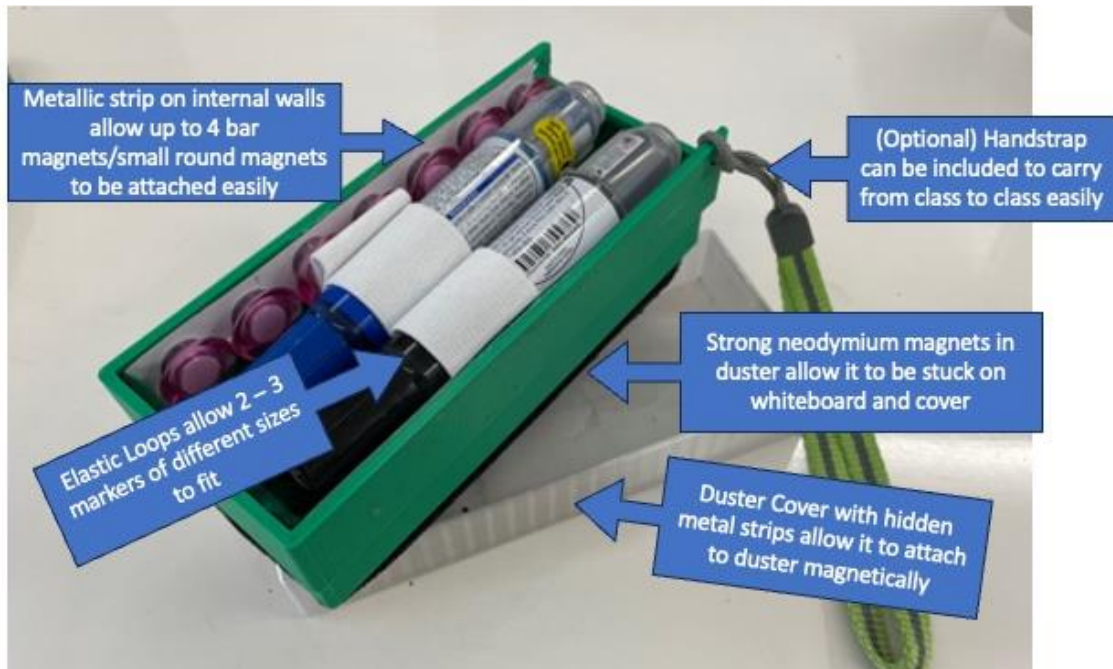
magnets and will be strongly attracted to the metallic strips (*see section IV “internal assembly of duster”*).

Based on the feedback from the respondents, we made a couple of improvements to the prototype. One of such improvements include making the duster cloth removable (like fitted bedsheets) over the foam pad, so that it can be easily replaced once it gets too dirty. We included velcro strips on the duster body and the foam pad for easy removal (*see section IV “internal assembly of duster”*). This makes our design more user friendly and allows the user to replace the cloth easily. It is also more environmentally friendly. Instead of frequently throwing the entire duster away (which is made of plastic and styrofoam) whenever it is too dirty, teachers now have the option of either washing, or buying replacement duster cloths (*circled in red in section IV “internal assembly of duster”*) which can be produced and sold separately, along with the duster when dirty, and continue to use the duster for a longer period of time.

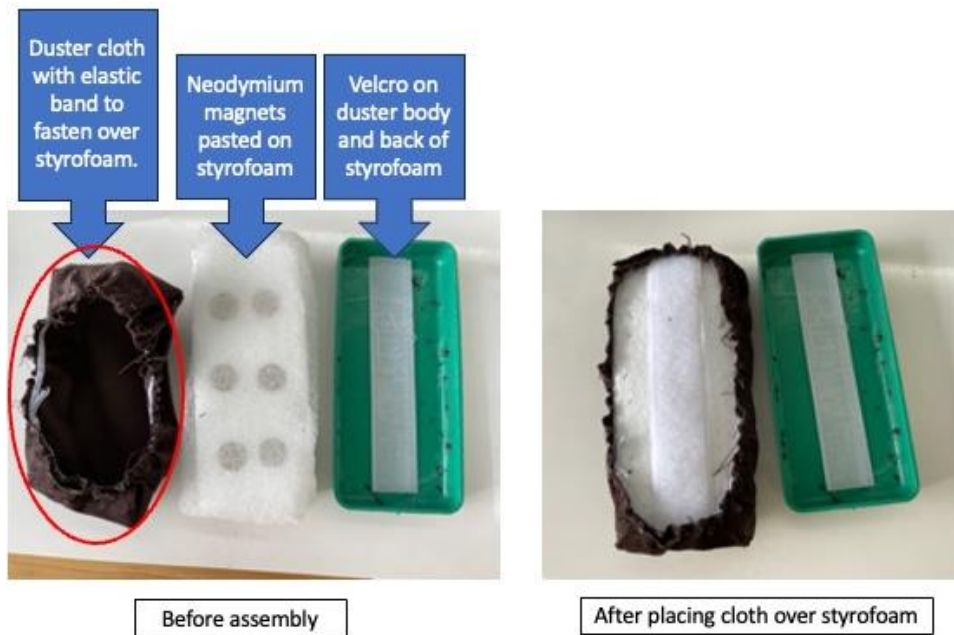
Another improvement includes the addition of a short strap. The strap allows teachers to hang the duster on their bag or easy hand carry and to prevent accidental drops. Our design allows the teachers to have a neat bundle of whiteboard accessories of their own, so that they can quickly bring it along from class to class. As the duster is magnetic, it would stay on the whiteboard, reducing the likelihood of frequent drops during lessons. With this all-in-one duster, teachers will not have to worry about interruptions during lessons or have to deal with dirty or missing dusters/markers/magnets.

IV. Physical Prototype

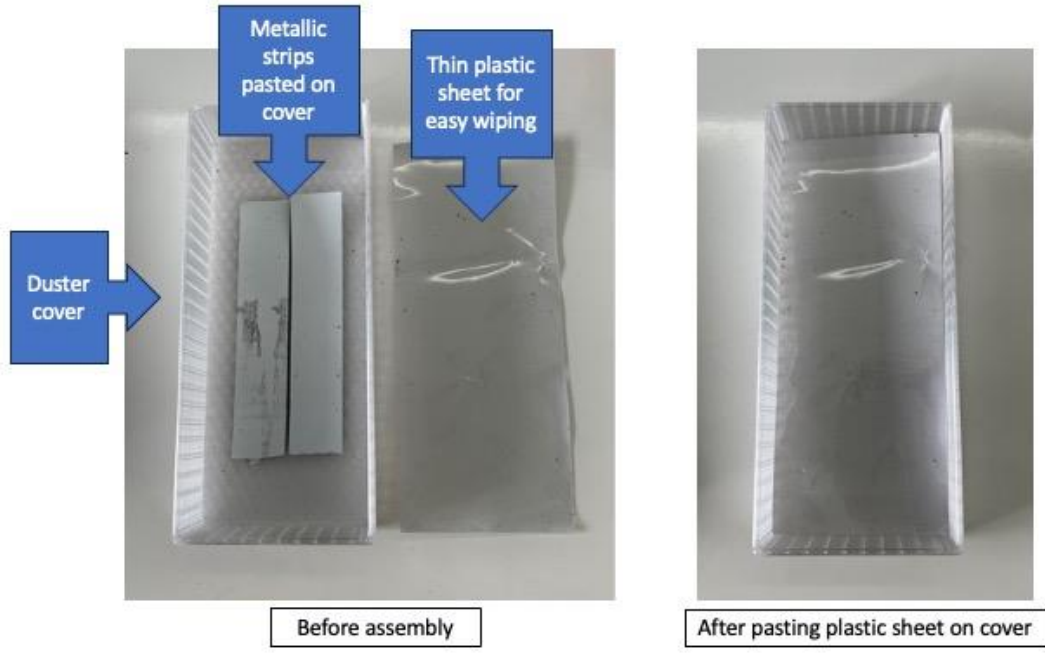
3-D printed prototype with explanation of the various design functions.



Internal assembly of duster



Internal assembly of duster cover



Sample of Prototype when stuck on whiteboard





Different combinations of stationery to suit individual teachers' preferences

- 1) Combination A - 3 markers and bar magnets (with duster cover, hand strap)



- 2) Combination B - 2 markers and round button magnets (with duster cover, hand strap)

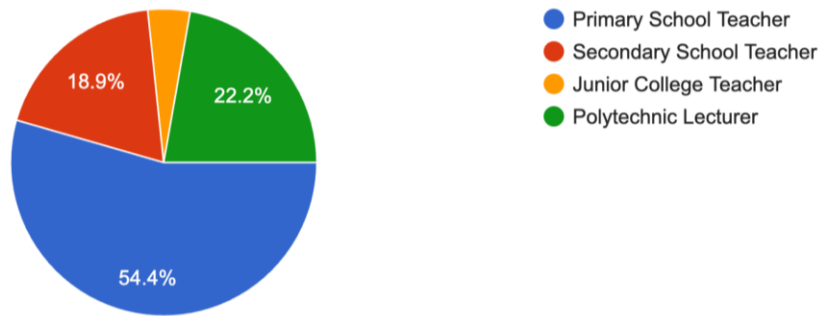


ANNEX

A total of 10 questions were asked in the survey. (<https://forms.gle/4LxnPAgGw6d375nD7>)
We received a total of 90 responses. Our findings are illustrated below:

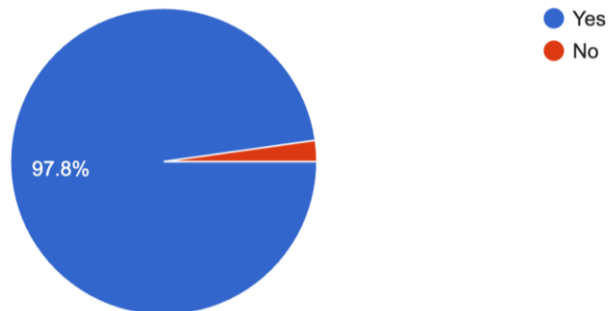
Q1) Please share with us if you are a current/former

90 responses



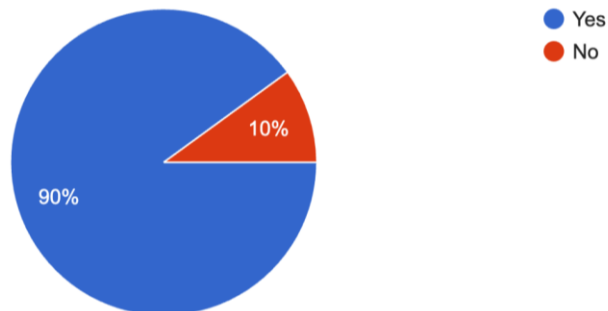
Q2) Do you use markers, duster OR magnets in class?

90 responses



Q3) Do you bring your own marker OR duster OR magnets to class?

90 responses

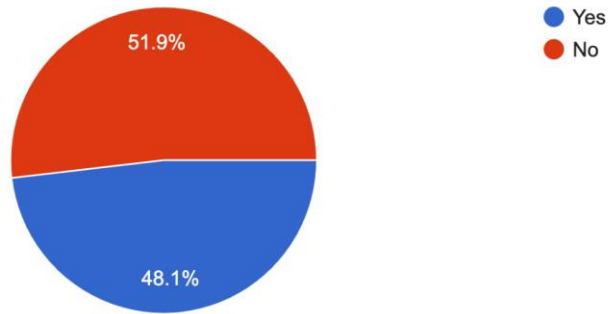


(Q4 and Q5) For teachers who answered **Yes** to Q3:

To find out whether teachers find it a hassle to pack or locate their classroom stationery as they move from class to class

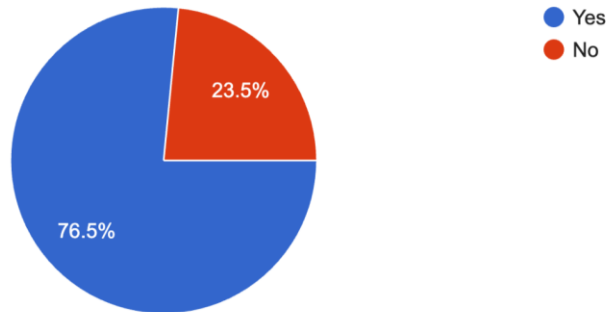
Q4) Do you find it troublesome when you have to pack up and bring markers/dusters/magnets from class to class?

81 responses



Q5) Do you ever forget and lose any of the above items?

81 responses

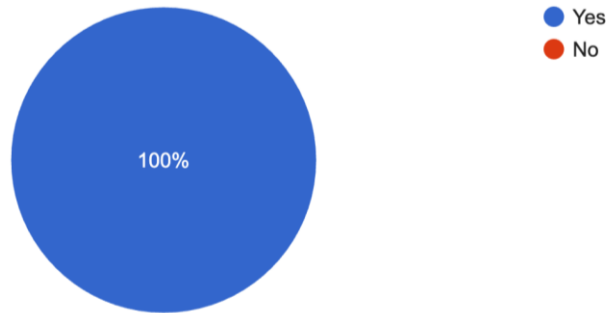


(Q6 and Q7) For teachers who answered **No** to Q3

To find out whether those teachers encounter inconveniences such as lost or damaged classroom stationery.

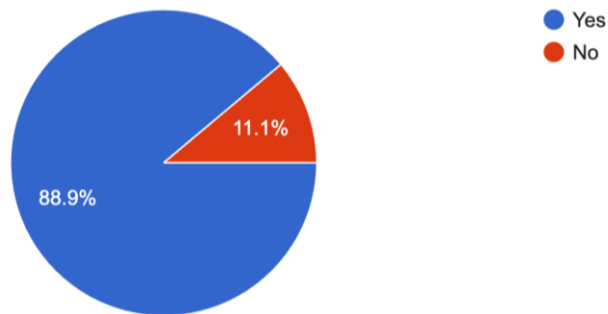
Q6) Have you ever entered classrooms while dusters are dirty/missing OR markers are missing or ran out of ink?

9 responses



Q7) (if "Yes" to above question) At that point, would you wish that you had brought your own classroom stationery?

9 responses

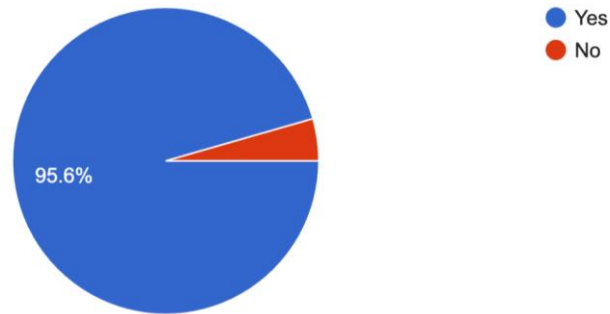


(Q8 to Q10) To all surveyed teachers.

To seek your opinion on our all-in-one duster design

Q8) Would it be more convenient if the markers, dusters and magnets could all be located together (i.e. one item to keep in your bag)? You can reference the below picture of our prototype.

90 responses



Q9) Would you be likely to bring and use this duster as your personal classroom stationery in classes? Why? /Do you have any suggestions?

Overall, 70% of respondents indicated that they would be likely to bring it with them as their personal classroom stationery.

Some of their comments are classified broadly in the following table.

Portability	Space efficiency	Relevance
No, I will be worried that the duster cover drops off and my bag will get marker stains from the dirty part of the duster.	It save space	If it's functional and all in one, why not?
Yes. Is compact	Yes. It stores everything in one place.	To carry the duster everywhere is not practical because the ink dust can be messy.
Yes. Portable, lightweight and convenient	Maybe, would be great if can put in 3 markers as I like to use more colours on whiteboard	I love the individual holder for the markers! :) magnet idea is great too to stick onto the board👍
Leave it in class. 2 in 1. Storage space.	Yes. It is more convenient but the problem is that it can contain limited 2 different colour markers.	Yes. Should place it on every classroom's whiteboard instead of the teacher bringing it to class. I prefer to carry a small stationery box to class.
I wouldn't mind but most likely I will forget to bring it over to another class.	Will be good if it can fit more than 2 markers and can be aesthetically pleasing.	Yes. Portable, lightweight and convenient
Yes. Ease of having to store the markers in another place/bag.	You could consider allowing it to hold more markers and including a cover for the duster	Probably need to work on the ergonomics. Not sure how easy it is to wipe the board as it looks bulkier and heavier. Might need a top cover too
Easier to carry around and can use the marker immediately instead of trying to find them in a pencil case full of other stationery.	Instead of storing the markers in the duster, can have holes on the long side of the duster like a pen holder. In this way, it can hold more different colour markers by inserting in the holes.	If you are able to have a cover on the duster that is attached to it (to prevent losing the cover), it might be user friendly to bring it around with us to the classroom. In addition, with the movement towards ICT teaching, we do use iPad and Apple Pencil, or laptop pencil to teach as well, the frequency of using markers is not as high

National Design Project 2023

<p>I teach many different classes as a music teacher so this contraption may not be at every class I go to, or I may forget to bring it along</p>	<p>Current prototype cannot hold many strip magnets. 2 might not be sufficient.</p>	
<p>Prefer to carry own markers to avoid unnecessary time wasted looking for markers</p>	<p>Compartment for refiller</p>	
<p>Probably a cover for the duster when not attracted to the whiteboard.</p>	<p>Maybe allow for teachers to personalise it in terms of design. Like a slot for names . Some other stationary teachers also need a red pen etc, so an additional pocket for a pen or 2 would also be good. Could also add a simple strap .</p>	
<p>Have a cover to keep the markers in. Ensure the fabric of the duster does not fray easily</p>		