

Hwa Chong Institution

Project Work

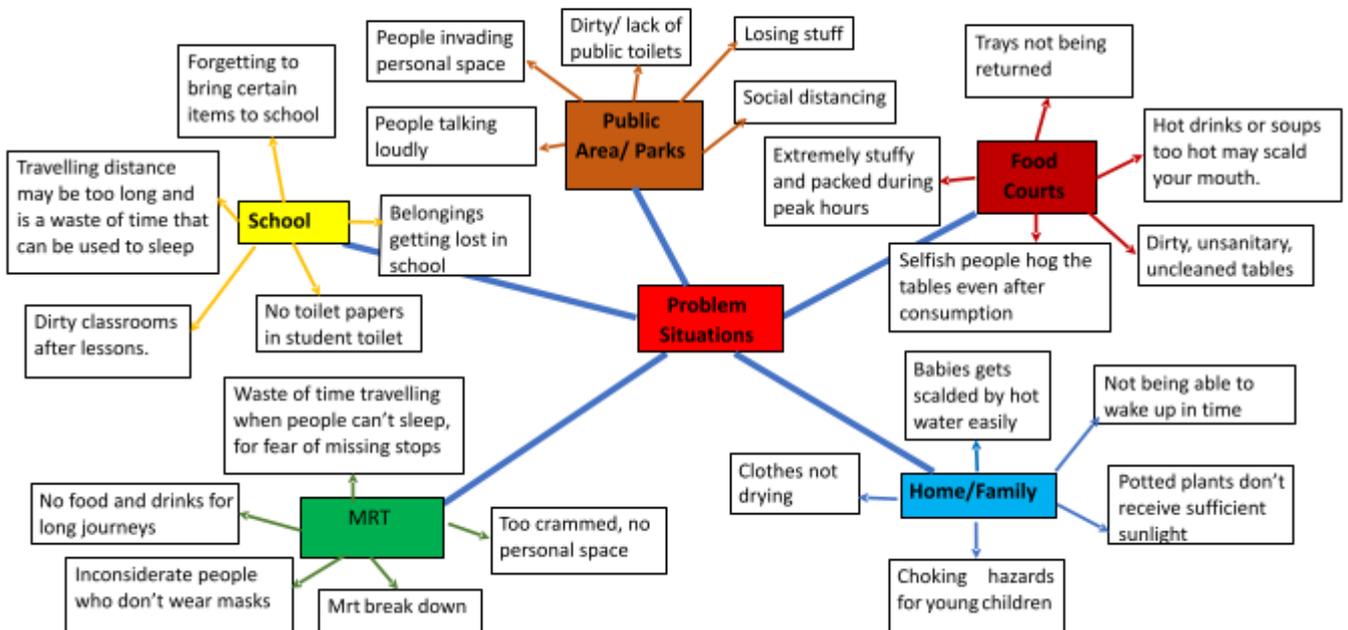
Category 3 Inventions Log Book

Title of Project: Stirmometer
Group Name: 3-12
Group Members: <ol style="list-style-type: none">1) <u>Dominic Tan Po Tai (2p2)</u>2) Ryan Quek Kai En (2i1)3) Timothy Oh Hao An (2i1)4) Neo Rui Feng Nicholas(2i1)

1. Problem Finding

1A. List of problems

Identifying the problem



Our group had studied and went around the following areas and finalized some common problems

Home/Family

- 1 Not being able to wake up in time
- 2 Potted plants don't receive sufficient sunlight
- 3 Babies get scalded by hot water easily
- 4 Choking hazards for young children
- 5 Clothes hung outside don't get dried fast enough

Mrt

- 1 During the morning peak hour the train suddenly breaks down.
- 2 You cannot drink during long journeys
- 3 Too crammed, no personal space
- 4 People don't wear masks
- 5 People can't sleep despite long travelling time for fear of not waking up in time

School

- 1 Sometimes you can't find any toilet paper in the student toilet.
- 2 Dirty classrooms after classes
- 3 Forgetting to bring certain items to school
- 4 Belongings getting lost in school
- 5 Waste of time travelling to school

Food courts

- 1 You may not find any place to sit down and enjoy your food during lunch/dinner time.
- 2 Hot drinks or soups too hot may scald your mouth.
- 3 Tables can be very dirty
- 4 People don't return trays
- 5 People stay at tables even though they have finished eating

Public Area/Parks

- 1 Empty cups or bottles left on the sitting bench and dirty the area.
- 2 Not enough public washrooms in the parks.
- 3 People litter
- 4 Flowers are always picked/ trampled on
- 5 Not much space for joggers and cyclists

1B. Considerations

Consideration 1:

After inspecting the problems thoroughly, we decided on the problem as it affects infants, children, adults and senior citizens, faced by all ages. It happens quite often at home and in food courts.

Consideration 2:

It's easy to solve, and within our means too. It's just something not solved well yet, and there are existing flaws in the other solutions.

Consideration 3:

Can prevent others from getting injured

Consideration 4:

Cheap to solve as materials aren't expensive

1C. Other considerations

Considerations for Selection	Problems			
	#1 Clothes hung out don't dry fast enough	#2 Scalding from hot liquid	#3 Dirty unsanitary tables at canteen	#4 Dirty classrooms
Consideration 1 impact of the problem	3(can cause delay in important events and necessary uses such as job interviews)	4(people can get burnt and scalded)	2(reduce efficiency of dining areas)	1(is causes inconvenience and causes classroom to be unsightly)
Consideration 2 How simple is it to solve	1(Have to buy extensive dryers or more heat producing technologies, can be hard to find)	2(Can be solved with thermometer, which is easily accessible due to how cheap it is)	3(Simplest to solve, students can do it too)	3(Simplest to solve, students can put in effort to clean the classrooms)
Consideration 3 How cheap is it to solve	1(have to buy expensive dryers, due to water, or hold a fan there, wasting time)	4(The materials are cheap to get)	2(Paper towels and hand sanitizer can cost a lot to buy if used a lot)	3(It does only requires reusable material like mops and brooms)
Total Score	5	10	7	7

2. Define the Problem

2A. The Problem is:

When you drink hot drinks or soups you may be unaware that they are too hot, and as a result you may scald your mouth. Hence, you might get ulcers or blisters, causing great discomfort.

One example is when a mother prepares the milk for her baby, the temperature of the milk may be too high and the baby will get their mouth scalded.



Different age groups are able to accept hot drinks at different temperature ranges so it is quite difficult to set the standard temperature for everyone.

However, this problem involves everyone in our society. Not just hot liquids, sometimes hot food when consumed, burns are caused on the lips & tongue. Sometimes, the upper palate of the mouth also



gets burnt. Since, once we realize it is hot, we spit the food out and hence the effect is lesser. In case of hot liquid burns caused internally, before one can sense that it is hot, we swallow it causing burns to the entire mouth, inner tongue and throat, which can lead up to a first-degree burn, but oftentimes a blister or an ulcer. Since we swallow the hot liquid before our reflexes react and spit it out, it leads to severe third-degree burns. Treating such burns is a challenge as the mouth is slightly less inaccessible and they are painful. Normal treatment of burns includes running burnt areas under cold water for 15 minutes icing it, which is difficult seeing as it will be very cold if icing, or uncomfortable to hold the head for 15 minutes, and can't be patched with plastic, as such people will have to deal with the pain. Studies by the world health organisation have also shown that drinking liquids over 60 degrees celsius regularly with smoking or high liquor consumption will increase your chances of esophageal cancer. Many studies conducted on animals have also shown an increased rate of esophageal cancer without alcohol or cigarettes although not enough human tests have been conducted to prove this.

<http://www.saaraams.com/blog/burns-caused-by-hot-liquids/>

<https://cnalifestyle.channelnewsasia.com/wellness/hot-coffee-oesophageal-cancer-1051254>

4

2B. Existing solution

Existing solution to solve this problem situation are as follow:

For infants, the mother will usually try out the drink using their fingers or using their wrists to test the heat.

Some mothers may use a heat sensor spoon to test the drink, as the spoon will change their colour when it is too hot.

Will change its colour to yellow if it is hot.



Testing the hotness of milk (inaccurate)

Reference:

<https://images-fe.ssl-images->

[amazon.com/images/I/81nSo+2pnNL.AC_UL160_SR160,160.jpg](https://images-fe.ssl-images-amazon.com/images/I/81nSo+2pnNL.AC_UL160_SR160,160.jpg)

For adults normally they will scoop a small amount and try out the drink before they start drinking. If it is too hot, they may use a stirrer or add an ice cube to cool it down before drinking. Smoke might also indicate extreme heat, but is unreliable as melted chocolate can be very hot but will not have smoke to indicate anything.

Some of them may even use their fingers to test the temperature of drinks or foods.



Testing the hot drinks by sipping



Smoke coming out from very hot drink



Use finger to test



All the methods used are not very reliable and you may wrongly just the hotness or your fingers or tongue may get scalded, especially with solutions with hot water just added.

3.Our Big Idea

3A.Our proposed solution:

To design and make a heat sensor spoon/stirrer that can be used to detect the temperature of the drinks or soups and indicate if it is safe for consumption. It also can use it as a normal spoon or stirrer to cool down the drink or dissolve powder easier.

3B. Potential benefits to users:

1. The spoon/stirrer will be able to read the temperature of the drinks or soups or to show whether they are hot or safe to drink.
2. The spoon has a thermometer to show the temperature of the hot drinks or soups and will tell you if the drink is too hot. (with colour markings/label stickers/words on screen)
3. If the drinks or soups are too hot you can use this spoon to stir them to bring down the temperature to the safety level.
4. Even with the above functions, the spoon can still act as a spoon.

3C. How is it better:

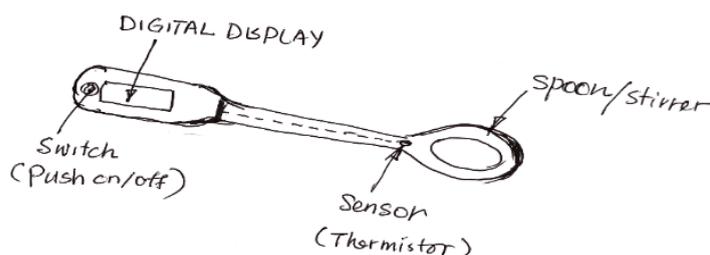
It can show the temperature more accurately than the heat sensor spoon and will tell you when it is too hot unlike the thermometer spoon. It is also a much cheaper option as it does not need any battery.

3D. Problems we expect:

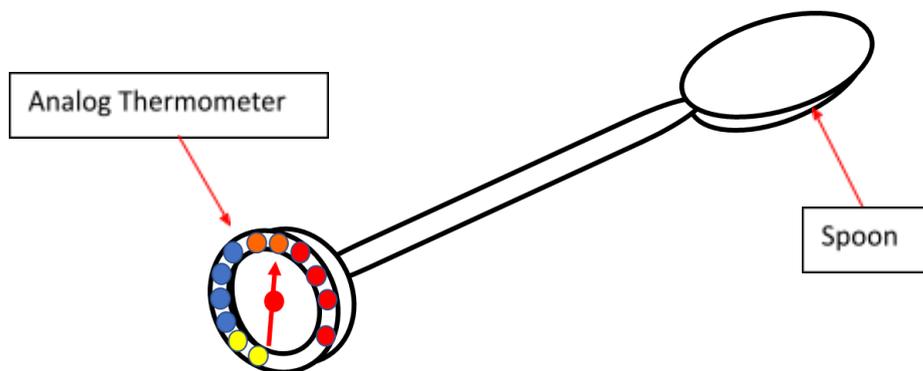
As we are only Sec 2, we will need to search from the website about the working principles of the heat sensor circuits and to find a suitable type of heat sensor products for our invention. We will consult our mentor and teachers about the hands on and construction of the project.

We may make use of the analog thermometer for our project as it does not need any battery to operate.

3E. Our milestones



1st milestone: Our initial design was to combine a thermometer and the spoon together and make use of the thermometer as a heat sensor to detect the temperature of the drinks or soups.



2nd milestone: Our second design was to remove the battery entirely and convert the switch to a thermostat, so it does not require a battery to operate, and can be used without the danger of poisoning the drink.

Project timeline:

1. Group discussion, investigation and research before we choose our proposed project.
(2 weeks)
2. Select the final proposed project and discuss with our mentor for approval.
(2 weeks)
3. Collect information and data on how to design the proposed project and carry out the testing of the prototype and decide the final solution. (6 weeks)
4. Construction of prototype and modelling for testing. (5 weeks)
5. Submission of the final report and presentation of invention(3weeks)

3F. Our target audiences:

Our invention is for everyone from infants to teenagers, adults and old folks. This invention will help them to prevent scalding by hot drinks or soups.

Compare our invention with the existing sensor spoons sold in the market:

1. The heat sensor spoon available in the market works on changing the colour of the spoon but does not know how hot the food is and changes at the slightest temperature changes. This type of spoon is mainly used to test the food for the infant but it is still not very reliable as we only know the food is hot but not very sure whether it is very hot or just safe to let the baby eat the food.



2. The digital thermometer spoon is meant for mothers to prepare the baby food. It is only about 3 inches and measured up to 60°C only. It is not suitable for other age groups, as it is tedious to test food bit by bit.



3. Spoon with a thermometer probe is a long spoon with a temperature probe. It is used to stir hot syrup and check the temperature but can't be used as a spoon to scoop drinks.



4. Spatula and thermometer are used to stir and check the temperature of soup or syrup in larger pots. It is not suitable to use it as a spoon for drinks. It is very cost inefficient and isn't worth it.



5. The colour changing mug is worked under the principle of thermochromism. When hot coffee or drink is poured into the mug this unique thermo-sensitive colour will turn transparent and any photograph or image that is printed on the mug can be displayed in all its glory. But this again we do not know how hot the drink is. As the paint will change its colour at about 70°C and above.



4. Construction or modelling process

4A. Choose of materials for the prototype or project:

The analogue thermometer

The advantages are:

Installation is easy and simple to maintain

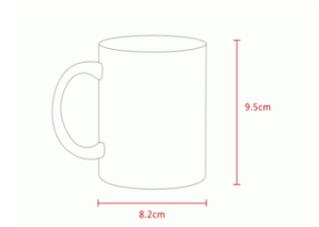
Temperature range is wide and costs less.

Linear response, robust and simple.

As we will use the mechanical thermometer in our invention. We will use the Bimetal thermometer with a long probe so that the sensor at the end of the probe can detect the temperature of the drinks. We decided to use the one with the probe about 13cm and the dial diameter about 3cm.

Reasons:

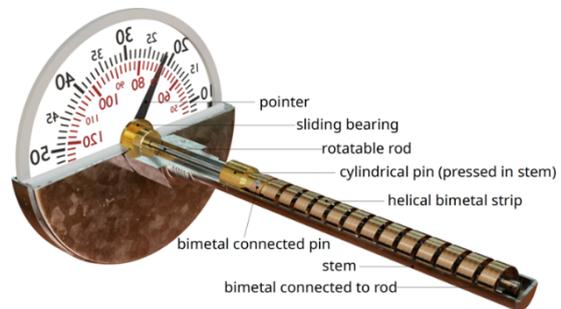
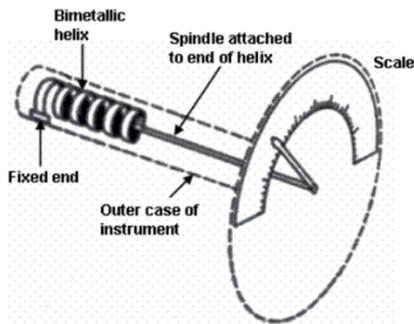
1 The average depth of a cup for drinking is about 9cm so that the dial will not immerse in the water.



2 The dial diameter must not be too big as it is quite difficult to hold and keep.

3 The temperature range for hot drinking water is only up to about 100°C.

4 This analog thermometer can work without any battery. It makes use of the bimetal strip to detect the heat.



4B. The materials suitable for the body and spoon of the stirrer

Material	Property	Cutting/Shaping	Is it easily available
----------	----------	-----------------	------------------------

Metal	Hard, durable and will not break easily. It can withstand high temperatures and is a good conductor of heat. It may change the acidic drink property.	It can be cut and shaped by using a hacksaw, drilling machine, filing and sanding.	Yes
Wood	It will not heat up easily even in hot drinks or soups. It is nontoxic. It will absorb water and get stained easily.	It can be cut or shaped by using a handsaw, drilling machine, filing and sanding.	Yes
Plastic	It is colourful, durable and very flexible. It is a heat insulator and some of them cannot stand high temperatures. It is not eco-friendly and some plastics are toxic.	It can be cut and shaped by using a saw, drilling machine, sanding and polishing. It can be formed by using mould.	Yes

Cutting and shaping tools, materials and accessories needed to make the invention.



(1)



(2)



(3)



(4)



(5)



(6)



(7)



(8)



(9)



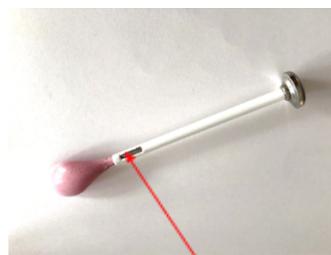
(10)

- 1 Stainless steel 304 straw is used to make the body. It is very strong and durable.
- 2 Wooden dowels are used to make the handle for the upper body for your fingers to hold as the wood will not conduct heat.
- 3 Stainless steel spoon is used to make a spoon of the stirrer.
- 4 Portable electric drill is used to drill holes for the wooden handle and to countersunk the hole at the end that joins the thermometer.
- 5 Hacksaws can be used to saw the steel tube and wooden dowel to length.
- 6 The vice or clamp is used to hold the materials firmly while sawing or cutting.
- 7 The files are used to file and shape the materials.
- 8 The drill bits are used to drill holes for the handle.
- 9 The countersunk bit is used to enlarge a drilled hole for the handle.
- 10 The sandpaper is used to finely sand the wood and steel parts after cutting.

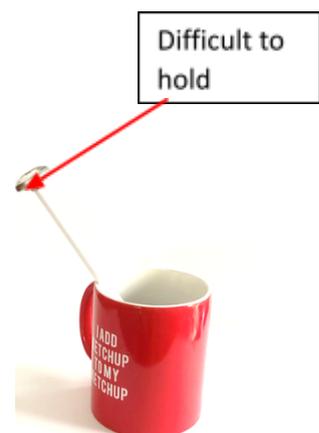
4C. Construction of prototype for our invention

Prototype 1

We made use of the polypropylene for the body and the spoon.



Opening for the heat sensor probe to detect the temperature



Difficult to hold

Stirrer in the cup

Benefits of Polypropylene

The use of polypropylene in everyday applications occurs because of how versatile this plastic is. For example, it has a high melting point compared to similarly weighted plastics. As a result, this product works very well for use in food containers where temperatures can reach high levels — such as microwaves and in dishwashers. With a melting point of 320 degrees F (160°C), it is easy to see why this application makes sense. It does not absorb water like other plastics.

It does not mold or otherwise deteriorate in the presence of bacteria, mold or other elements.

We poured hot water into the cup and the handle part remained cold but we found that it is quite difficult to grip and stir as the plastic tube is small in diameter.

Prototype 2

We used pine wood for the body and the spoon. The hole is drilled through the wooden body to insert the sensor probe.

The sensor point is exposed at the back of the wooden spoon to detect the temperature.



Benefits of wood

Wood is not a heat conductor so when put in the hot drink it will not heat up. It will not change the taste of acidic foods.

It is fully composable and environment friendly.

We found out the handle was quite comfortable to hold and to stir the spoon and it would heat up even when the water was very hot.

But the wooden parts would absorb water and also stained when the drinks

was colourful. It also needs time to dry up before you can keep it. The end of the sensor probe might hurt your mouth when you used the spoon to drink.



Sensor probe exposed at the back of the stirrer

Prototype 3

We used stainless steel for the body and the spoon. A stainless-steel tube of $\varnothing 6\text{mm}$ was used for the body to join the thermometer and the spoon. A small opening was cut at the end of the tube for the sensor probe to detect the temperature.

Benefits of stainless steel

It can withstand many years of usage without showing signs of damage. It is proven to have greater strength than any other materials. It has a high resistance to stain, rusts and water damage.



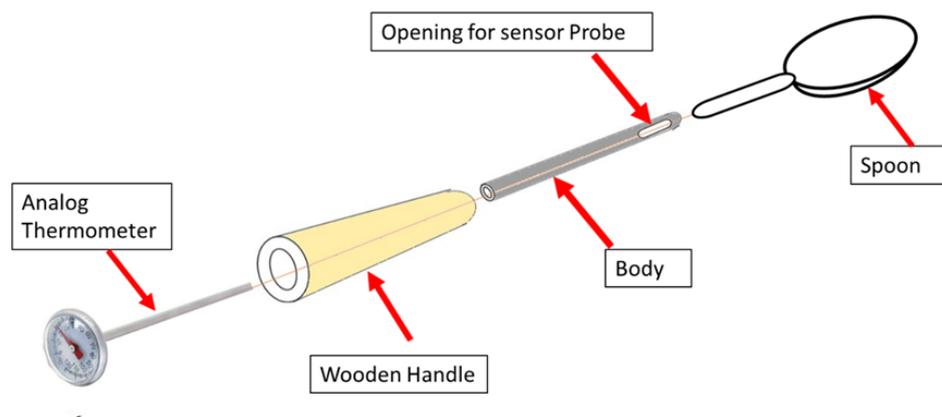
Sensor probe is exposed at the back of steel tube

Most importantly it is non-toxic and perfect for making cutlery.

We found that the prototype was very easy to dry up after use and would not get stained even if the drink was colourful. But when the drink was very hot the steel body would heat up making it difficult to grip the handle to stir the drink.

Our final choice

After careful considerations and discussions, we decided to use stainless steel for the body and spoon of our invention. As wood will easily stain and absorb the water and plastics materials are not eco-friendly. A short wooden handle is joined just after the thermometer dial to make the stirrer easy to hold but not immerse in the drink.

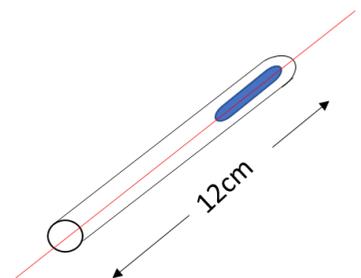


Detail construction of the final prototype or invention

1 Cutting the stainless steel for the body of the stirrer

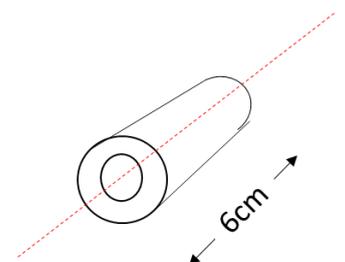
We use the stainless-steel straw of 6mm to saw to the length of 12cm.

Use the file to file an opening for the sensor probe and cut open the end as shown in the diagram.



2 Saw the handle of the stainless teaspoon and file to fit into the end of the body.

3 Saw the wooden dowel to the length of 6cm and drill a through hole of $\varnothing 6.5\text{cm}$ for the steel body to go through it. Countersunk one end and shape the other end with file and sandpaper as shown in the diagram.



4 Assemble the parts as shown in the diagram and press close to the end of the steel tube.

5 use food friendly epoxy to fill the spacing in between the spoon and sensor probe.

Testing of the final prototype or invention

- 1 Pour very hot water into the cup and put the stirrer in the cup.
- 2 take the time the thermometer reading reaches the stable reading.
- 3 use the digital probe thermometer to check the different readings of the two meters.
- 4 pour warm water and repeat the same procedure 2 and 3.
- 5 Pour cool water into the cup and repeat the procedure 2 and 3.
- 6 Compare the readings and time for the two types of thermometers.



Very hot water



Warm water



Cool water

Records of the readings and times taken by our invention and digital thermometer

Test No	Temperature (°C)		Difference (D - I) °C	Stabilisation Time (sec)		Difference (D - I) sec
	Digital (D)	Invention (I)		Digital (D)	Invention (I)	
1	82.5	80	2.5	31	40	9
2	52	50	2.0	23	30	7
3	33.7	33	0.7	13	17	4

Analysis of the result taken by our invention and by digital probe thermometer

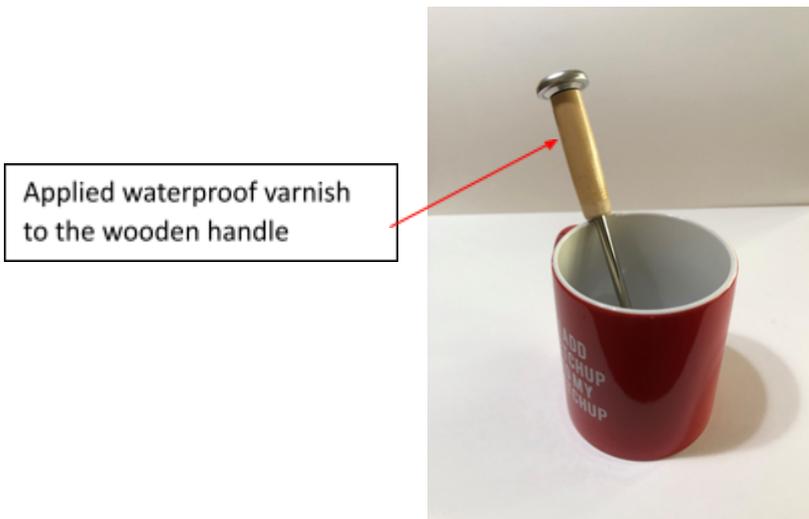
When the water temperature is high our invention takes a difference of 9 seconds to reach the stable reading as compared to the digital device. But when the water temperature is

lower the difference is smaller. As for the accuracy of the temperature taken, the difference between our invention and other digital devices differs about only 2.5°C to 0.7°C .

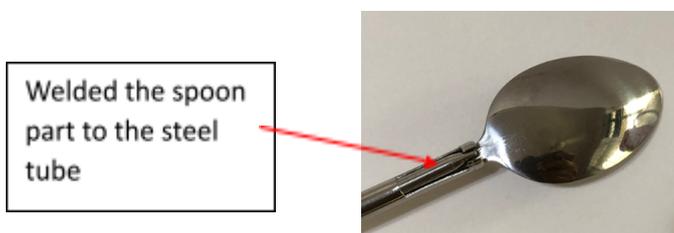
We are quite satisfied about the result of our testing as our invention is only used to find out the temperature of the drinks whether it is suitable for you to drink without scalding our mouth. The difference of about 2°C is not an issue.

5 Improvement and modification of our invention

1 As the wooden part of the handle is not touching the drink it is only for us to hold the stirrer comfortably and not to heat up by the drink. So, we can apply a layer of waterproof Wood varnish so that water will not be absorbed by wood.



2 To use a gas welding torch to join the spoon to the stainless-steel body, the joint will be stronger and look nicer.



Gas welding torch

3 To use stickers to indicate the safety temperature for the user. For infants it is up to 40°C and for adults it is up to 65°C.



For children use



For adult use

Our final invention

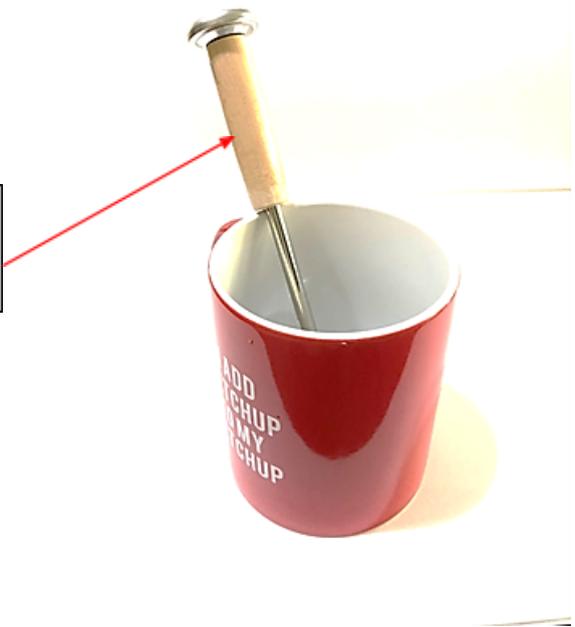


Before assembly



After assembly

Wooden handle
doesn't immerse
in water



References

<http://www.saaraams.com/blog/burns-caused-by-hot-liquids/>

<https://cnalifestyle.channelnewsasia.com/wellness/hot-coffee-oesophageal-cancer-10512544>

<https://images-fe.ssl-images->

amazon.com/images/I/81nSo+2pnNL._AC_UL160_SR160,160_.jpg

<https://www.amazon.com/Kitchen-Craft-Silicone-Thermometer-Spoon/dp/B00BIJQWC>

<https://pubmed.ncbi.nlm.nih.gov/18226454/>

<https://www.amazon.com/Kitchen-Craft-Silicone-Thermometer-Spoon/dp/B00BIJQWC>

https://www.amazon.co.uk/dp/B00DM2ZTRM/ref=wl_it_dp_o_pC_S_ttl?_encoding=UTF8&colid=1QRILCS0Q8P02&coliid=I3JEXU1DXS4MLQ

<www.scienceabc.com/pure-sciences/science-of-magic-mugs-how-does-heat-sensitive-paint-wor>

<https://pubmed.ncbi.nlm.nih.gov/18226454/>

<https://blog.thermoworks.com/thermometer/underlying-costs-inexpensive-thermometer-99-thermometer/>

<https://www.elprocus.com/what-is-a-bimetallic-thermometer-construction-and-its-working/#:~:text=Bimetal%20thermometers%20are%20designed%20with%20a%20bimetal%20strip,t%20the%20higher%20side%20of%20the%20metal%20rod.>

<https://www.webstaurantstore.com/guide/637/different-types-of-thermometers.html>

<https://www.polytechnichub.com/bimetallic-thermometer/>

<https://www.tec-science.com/thermodynamics/temperature/how-does-a-bimetallic-strip-thermometer-work/>

<https://www.thoughtco.com/what-is-polypropylene-820365>

<https://i.ebayimg.com/images/g/HnQAAOSwja5e2wQq/s-11600.jpg>

<http://www.forksandspoons.it/materials-used.shtml>

<https://www.delightedcooking.com/what-are-the-pros-and-cons-of-using-plastic-cutlery.htm>

Some photographs taken in the progress of making our invention

