BRI Journal

A fascinating dive into the research carried out by students in the Baltic Research Institute at Liverpool Life Sciences UTC

In this edition, read about the impact of the ancient Egyptians on medicine and the potential of the mealworm gut microbiome to break down non-recyclable plastics

BRI Baltic Research Institute

Liverpool Life Sciences UTC

THE STUDIO

Northern Schools Trust

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Meet the new editorial team...

Foreword from the new editorial team

This is the new winter edition of the Baltic Research Journal. In this edition we aim to exhibit the research produced in the Baltic Research institute by past students in Liverpool Life Sciences UTC and the Studio School Liverpool. Our article writers have taken a wide range of EPQ topics completed by sixth form students and have each worked on articles about them. From Ancient Egyptian medicine to the best material for dentures, this edition contains a variety of interesting subjects.

We want to showcase the original work conducted by our students whilst also making their niche interests accessible to a wider audience. For our next edition we are looking for any collaborators who may be interested in contributing to any STEM based research or talking to our digital team about their specialty.We hope you enjoy this issue and we always welcome any feedback. Thanks for taking the time to read our articles.

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BRI

Original Research Article

Researcher - Sian Johnson
Editor - Fatima Mohamed

The impact of religion on medicine in ancient Egypt.

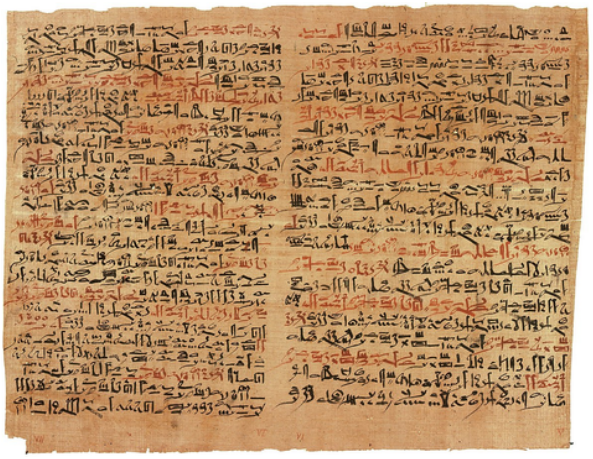
For her extended research project (EPQ), Sian Johnson researched and evaluated the effectiveness and impact of Ancient Egyptian medical practices. Sian examined the impact of religion on the development of medical and anatomical knowledge in ancient Egypt and assesses whether religion played a limiting factor in the amazing developments made by this fascinating civilisation.

Sian researched the history of medicine in ancient Egypt, finding highly sophisticated medical practices with varying treatments, and a deep understanding of human anatomy. She also found the Egyptians ability to utilise natural resources for remedies, (N.H Aboelsoud, 2010). Sian further researched the impact of ancient Egyptian practices as they served as the bases of medical practice for the following millennia, (Aldred, 1998). Reading Sian's research brought me insight into how far medical practice has developed and how the lack of basic scientific process and focus on religion has hindered medical advancement.

To find possible limitations on medical advancement, Sian focused on the merging of religion and superstition with medicine. She assessed that Egyptians believed that illness was caused by one's relationship with the universe e.g the deities they believed in (Zucconi, 2007).

Sian's research of the advancement of medical practices in ancient Egypt led her to the Edwin Smith Papyrus. Sian evaluated Egypt's medical advancements, finding that the papyrus, a medical text on surgery and surgical trauma, was the only one of its time to evidence a scientific approach to medicine and medical development. However she also acknowledged the text had imhotep, god of medicine, as its main figure as well as relying on religious rituals for treatment.

On top of that, her research demonstrated the vital role that personal hygiene played in ancient Egyptian culture, suggesting the importance of preventative measures in Egyptian medical practices, this extremely modern outlook on medicine is one of the policies employed by medics all over the world to this day. However, she found this was partly due to the religious belief that uncleanliness would make it more difficult for a spirit to be recognised in the afterlife, giving an insight into the positive impacts religion can have on early scientific developments.



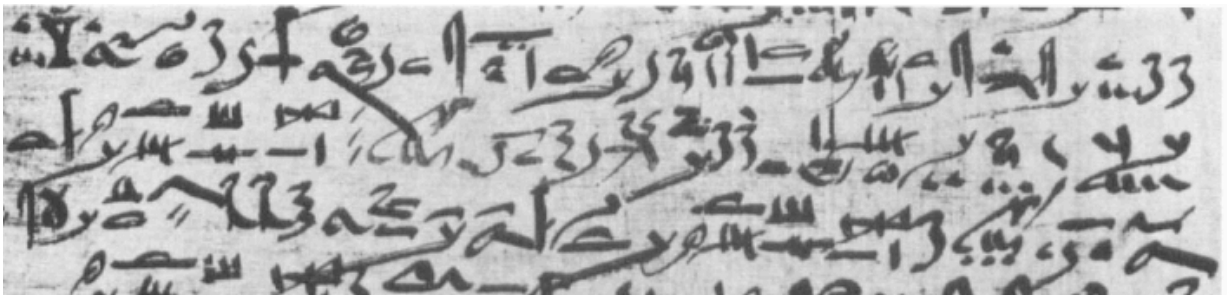
However, Sian argued there was a chemical approach to Egyptian cosmetics and hygiene products, ("Cosmetics, Perfume & Hygiene in ancient Egypt."). Doctors in ancient Egypt were the highest skilled medical practitioners of their time, and she found evidence that the high status of Doctors who helped treat commoners and Pharaohs allowed the establishment of accessible medical care in ancient Egypt. Free healthcare (at the point of use) and the NHS being one of Britain's greatest institutions is a fundamental example of how modern and developed Egyptian society was.

To conclude, Sian found, although ancient Egyptian medical practices were impressive for their time, a large proportion was based on religion and superstition and many treatments were in fact harmful such as the use of mercury in cosmetics. "The blurred lines between science and magic may have limited medical advancement."

Even in modern day society the relationship between religious beliefs and medicine is an important factor and can lead to increased risks for some groups due to factors such as vaccine hesitancy and not consenting to receiving blood transfusions. Despite the limitations which religious beliefs and practices may have had on the development of medicine in ancient Egypt, it is incredible how much this fascinating civilization advanced our knowledge and undertsanding.

Original research by Sian Johnson
Edited by Fatima Mohamed

Sian received an A* for her extended project and has gone on to start a lab scientist degree apprenticeship with United Utilities.



Original Research Article

Researcher - Will Tedds
Editor - Ava Knowles

Are mealworms the future for eradicating plastic waste?

Last year William Tedds, a former student, was worried about the detrimental effects of plastic pollution and how this might be fixed or reduced, so for his EPQ he decided to research this. Before reading his EPQ, I had a vague awareness of the issues surrounding plastic pollution however I had never done any research into the topic so was unaware of any solutions other than reducing usage. William's work was eye opening, interesting and unique. Below I will detail the different aspects of his research project and the experiments he carried out to reach his conclusions.

The issue of plastic pollution has become more mainstream in the last decade however some of the statistics are still frightening. For example, through his research, Will found that plastic production is expected to reach over 34 billion metric tonnes in 2050. The widespread use of plastic would not be an issue if it wasn't for its long degradation period which ultimately leads to landfills releasing harmful gases and toxins into the surrounding environment. However he realised that plastic is fundamental to industry and everyday life and if it is properly managed it will not leak into the environment and have a significant negative effect. The traditional way plastic waste is dealt with is through recycling, however only 45% of the UK's waste is ever recycled, a smaller percentage of this being plastic. Realising that the traditional route simply wasn't efficient, Will saw an opportunity to explore and develop a new way we can eradicate plastic waste and stop it affecting our natural environments.

Among the plastics contributing significantly to pollution, PET stands out. It is part of the polymer family and is most commonly used for domestic products such as textiles and packaging materials. Despite its widespread use, the rate of recycling on PET is low and its particular durability makes the already decades to centuries long degradation process longer.

A promising component in PET degradation is its monomer, Mono(2-hydroxyethyl) terephthalate (MHET). MHET is both a byproduct and a key intermediate in the process of breaking down PET. It plays a pivotal role in chemical recycling, where PET is broken down into its base components and then reformed into new PET. This cyclical process is essential for reducing PET's ecological impact and advancing sustainability in plastics.

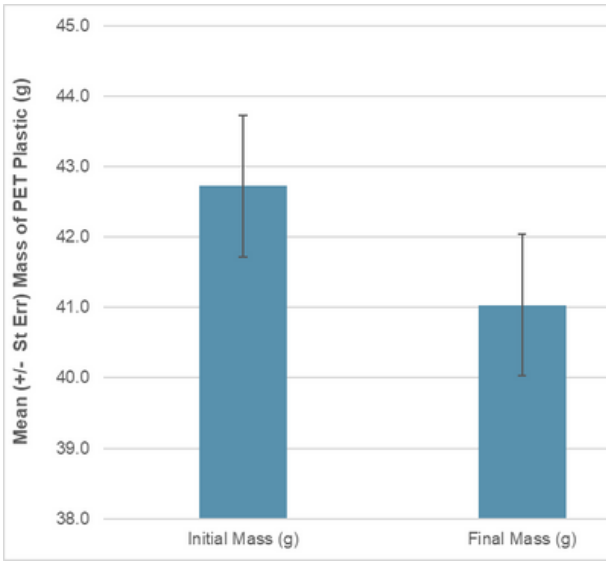
Taking his worries about the impacts of plastic pollution, William hypothesised that the microbiome of a mealworm (tenebrio molitor) would be able to break down certain plastics, specifically PET. Mealworms naturally feed on organic materials so William wanted to investigate whether they could have any effect on the degradation of plastic.

Before beginning the experiments, William gained professional insight from Professor Dave Hornby and Professor Lee Haines. Professor Hornby was able to help William refine his bioprospecting specifically for the mealworms, which was a new skill he picked up during the EPQ, and Professor Haines supplied him with resources and advice. Gaining this extra advice from experts helped to elevate William's work and develop his lab skills in general.

Access to the university standard labs in the CUC building allowed William to develop a thorough method, improving the standard of his research overall. He first had to create a suitable environment to house the mealworms. For this, he decided on acrylic tanks, maintaining temperature, lighting and diets that mirrored their natural habitat. By replicating the habitat of the mealworms, this meant Will's work was not affected by any extraneous variables and any change to the mealworms was purely down to the ingestion of PET.Will gave a section of the mealworms oats as a control and then the rest were given PET Will then tracked and recorded their growth and behavioural changes.

For the bioprospecting process, the internal microbiomes of the mealworms were extracted and cultured using Luria broth. This enabled Will to examine the degradation capacity of the microbiome on PET. After seven days, the plastic samples showed significant weight loss, indicating the degradation of the polymers. These results support the initial concept of an enclosed, controlled system in which plastic could be introduced for microbial degradation, offering a potential solution to the global plastic waste crisis.

Will's data confirms his hypothesis that the mealworm microbiome is capable of breaking down PET. In addition, the mealworms exhibited growth patterns similar to those in the control group that Will isolated, suggesting their ability to degrade PET would not be a risk to their health.



With global plastic production continuing to escalate, it is innovation and new ideas that will help to reduce the damage of the onslaught of plastic waste onto our already fragile ecosystems. Although a small step, Will's research is an example of how we can use different species, like the mealworm, to help undo the damage we have caused whilst not endangering the species we choose to use. The reduction of the reliance on traditional methods of recycling can only be a good thing, as it clearly isn't working, especially in the west where it isn't economically viable to recycle more than 50% of waste. Ultimately, this method could take one of the planet's most threatening environmental problems and create an inventive and eco-friendly solution.

Original research by Will Tedds
Edited by Ava Knowles

Will achieved an A grade for his extended project and now works for local biotech company Entropix who supported his extended project research.

Original Artefact

Researcher - Faith Mather
Editor - Dominion Ekhator

Developing a Mixed Reality Anatomy Suite for the BRI

Figure 1. Inside the virtual anatomy suite

Faith Mather was fascinated by anatomy and originally set out to design and create a physical room as an anatomy suite that students could use to develop their knowledge and skills. When Faith discovered the MERGE cube, a hands-on augmented reality tool for education, she decided to focus on developing a virtual anatomy suite utilising this technology.

Anatomy is a branch of biology and medicine that explores the structure of living organisms at a range of levels.

Gross anatomy is the structure of the body that is visible with the naked eye, involving skin, muscles, bones and digestive organs.

Microscopic anatomy is the study of the tiniest anatomical structures which are visible on a microscopic scale including cells and tissues. This technique allows us to focus on cells and tissues in more detail.

Comparative anatomy is the comparison of the structures of an animal or a plant with a different animal or plant structure. This is done in order to understand the adaptive changes they have undergone throughout evolution from common ancestors.

The use of anatomy suites in educational facilities Anatomy suites are large spaces used to teach anatomy to students from multiple courses. There are different types of anatomical models such as the models of the bones, nervous system and/or our muscles. Also individual models of organs such as the lungs or the heart.

Technological advancements have meant that the teaching of anatomy and physiology have changed significantly over recent years. Whilst physical anatomical models, animal dissections and the use of cadavers in medical schools are still widely used, digital technology has meant that a range of additional approached are used in combination with traditional approaches or sometimes replacing them.

For example the anatomage table can show 3D models of any part of the body at any time in great detail and can be used to allow students to perform virtual human dissections. In some Universities this is used as well as cadavers, but in others it has replaced the use of cadavers.

Figure 2. Use of anatomage table

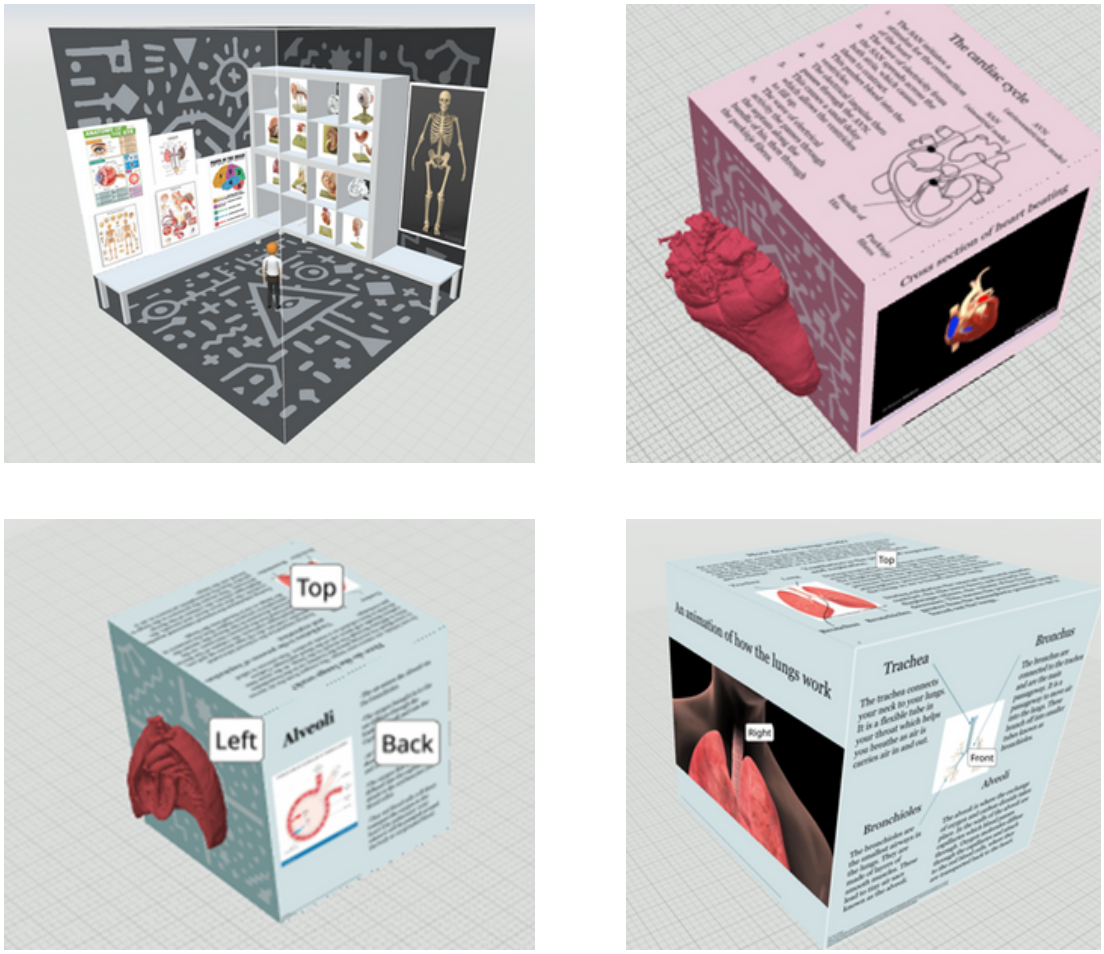


Figure 3. Development of the mixed reality anatomy suite using a MERGE Cube and the CoSpaces app (top left) and examples of content on the heart and lungs.

Faith found that developing a virtual anatomy suite gave her greater flexibility and as well as creating an overall virtual room (top left) she was able to create engaging additional content on each organ and system. This would allow users to not only visualise the structures of the organ but to learn about key processes through a range of different types of media.

Faith designed her virtual anatomy suite so that it can be viewed on a smart phone or tablet or for a more immersive experience the user can wear a VR headset and use the controllers to more easily navigate the room and content with the feeling of being inside the anatomy suite.

Faith's project has demonstrated the huge potential that immersive digital technologies can have in engaging learners and increasing the range of learning experiences that are possible. Whilst mixed-reality anatomy suites might not fully replace the role played by physical anatomy suites and models and the experience of dissecting animal or human tissue, they can certainly enhance courses and offer an engaging and exciting way for students of medicine and anatomy to learn.

Original research by Faith Mather
Edited by Dominion Ekhator

Faith achieved an A grade for her extended project and now studies zoology at Liverpool John Moores University

Original Research Article

Researcher - Luke Fearon
Editors - Finn Hattersley, Suzo Costley, Rhys Wilcox

A Comprehensive Review of Materials used in Dentures

This article is about a notable EPQ project written by Luke Fearon, his project is a comprehensive review on dental materials, intended to help analyse which material is the best for denture construction. The research was extensive and took into account numerous factors in order to facilitate the fair analysis of each dental material, commenting on both the strengths and the weaknesses of each dental material. The review came to a fairly simple conclusion ultimately ruling that the ideal denture material was titanium, but the most practical denture material was acrylic resin.

The student who wrote the article was inspired by his own desire to become a dentist. More specifically, he wanted to expand his horizons in the field of dentistry by performing some in-depth research into a specific dental topic for his EPQ. I'd say that in doing this, he succeeded, and expanded his impressive knowledge through careful, in depth research into dentistry. His EPQ will have helped him improve his academic research and writing skills, which are critical for future academia.

This review is primarily based around online research, tying an impressive number of sources together into one coherent conclusion. The online research done involved the use of resources provided in school, with extensive access to every kind of scientific source. The magnitude and quality of the research done reflects a high level of access to the resources and expertise needed.

Luke's research identifies the use of many materials for use in dentures one of which being feldspathic porcelain, which is compatible with an oral environment and aesthetically appealing to many. However, research shows that it cannot bear much pressure and is not very strong in general, and produces a clicking sound that irritates and aggravates some patients, so it is far from a perfect solution. Additionally, they are extremely expensive, with a full set costing up to £7000.

The types of denture material that Luke evaluated were those most commonly used, which are:

- Acrylic Resin
- Feldspathic Porcelin
- Zirconia
- Valplast
- Titanium

Luke judged the denture materials by the most important qualities required in dentures:

• **Biocompatibility** – the ability for a denture material to interact with surrounding oral tissue without causing harm or adverse effects such as irritation.
• **Aesthetic appeal** - the natural look and colour of a denture material.
• **Colour stability** – the ability for a denture material to maintain its colour over time.
• **Ease of repair** – the difficulty of repairing or modifying dentures when damage or changes have occurred.
• **Radiopacity** - the transparency of a denture material when being x-rayed allowing to distinguish between dental material and natural material and assess the absorption of the material in the bone structure.
• **Thermal Conductivity** – the ability of a denture material to transfer heat and a high thermal conductivity rapidly transfers heat which can cause damage to underlying oral tissue.
• **Longevity** – the length of time a denture can remain fit, functional, and appealing before needing replacing.
• **Water Absorption** – the ability of a denture material to absorb moisture from the environment as well as from saliva and other fluids.
• **Surface hardness** – the resistance of a denture material to indentation and scratching on its surface.
• **Rigidity** – the stiffness and inflexibility of a denture material helping to maintain its shape and resist deformation.
• **Impact Resistance** – the ability of a denture material to withstand sudden forces and impact without breaking or sustaining damage.
• **Flexural Strength** – the resistance of a denture material to flexing and bending without breaking or sustaining damage.
• **Porosity** – the presence of microscopic holes and voids in a denture material that can lead to the build-up of bacteria and other micro-organisms over time.
• **Cost** – the price of dentures for a patient.

Patients reported that the most important factors when considering dentures to them was the **ease of chewing**, **appearance**, and effect on **speech**

The findings of Luke's research show that Zirconia in dentures may be a revelation to dentistry as a 'metal-free' alternative to restorations as it is a ceramic biomaterial rather than the metal that is traditionally seen within dentures. Zirconia is attractive to both dentists and patients due to its properties that give it a high biocompatibility, temperature resistance, pressure resistance and pH resistance. The downside to Zirconia is that a phenomenon can occur when left exposed to moisture called Zinconia aging which negatively affects the properties of Zirconia but still appears to remain within the standard needed for clinical use.

Figure 1. zirconia dentures

Figure 2. feldspathic porcelain dentures

Figure 3. titanium dentures (pre finishing)

Luke's research also highlights another denture material worth noting: Valplast. Valplast is a type of denture material that is known for flexibility, made from nylon 12 and largely odourless. The tensile and flexural strengths of Valplast make it quite desirable for denture materials, and longevity, according to research, appears to be in the region of 5-7 years. Valplast does have some practicality issues, namely the water absorption, which due to the hydrophilic nature of Valplast, is quite high, and such a level of water absorption can lead to brittleness and discolouration. In addition, Valplast also is difficult to repair as it does not bond to acrylic resin, making repairs lengthy, and has poor thermal conductivity which can negatively affect patient acceptance.

Another compatible denture material demonstrated in Luke's research is titanium: studies found that titanium dentures caused around 0.6% of patients to suffer adverse reactions, in addition to high corrosion resistance and an impressive longevity of over 10 years. Also noteworthy is titanium's noteworthy strength and ductility allowing for precise fittings in the mouth of patients as it better conforms without suffering significant damages or breakage particularly often, as well as boasting tensile strengths which surpass that of valplast. It is noted that titanium has a high level of thermal conductivity allowing ease of patient acceptance. It should be noted that titanium has a very high strength to weight ratio allowing for a more comfortable fit for the patient. The cost of purchasing a single titanium denture is in the region of £1600, making it impractical for widespread use due to extreme cost.

Acrylic resin was ultimately the material decided by the EPQ writer, Luke Fearon, to be the most practical. Acrylic resin is known for ease of repair due to thermoplasticity, ease of manufacture and quick setting, allowing quick and efficient manufacture. It is also relatively easy to make aesthetically pleasing, and quite cheap compared to other materials.

Figure 4 acrylic resin dentures

Mechanically, acrylic resin can suffer from poor flexural strength and only lasts for about 5 years. Additionally, acrylic resin is quite porous, which can make effective cleaning a difficulty. Increasing the curing time can mitigate this problem. Low thermal conductivity has been reported, but also mitigated by the effective use of metals added to the material.

There are many good options for dentures for many different reasons however, what is seen as most desirable is for the patient receiving the denture to decide. If a patient desires a long lasting denture then a titanium denture may be the best option and if a patient desires aesthetics then a feldspathic porcelain denture may be the best option. Overall, it appears that the best of all worlds in terms of dentures whilst still being affordable are acrylic resin dentures and this contributes to their widespread use today.

Unfortunately, there has been a decline in dental health in recent years. This may be due to the cost of living crises and unhealthy diets. Most treatments are not covered by the NHS and many are sadly unaffordable for most people to feasibly take as options.

Original research by Luke Fearon
Edited by Finn Hattersley, Suzo Costley and Rhys Wilcox

Luke achieved an A* grade for his extended project and now studies dental surgery at the University of Liverpool.

Original Research Article

Researcher - Maab Ewad
Editor - Annie Knowles

Evaluating smoking cessation campaigns and better engaging young people in quitting smoking

Figure 1 example of existing campaign materials

The aim of Maab Ewad's EPQ was to research and evaluate the effectiveness of smoking cessations from the Department of Health and Social care to better engage young people in quitting smoking. It's well known that smoking is a huge problem within our society, particularly with young people as rates of smoking and vaping are at such high levels. Maab's EPQ highlights the importance of quitting smoking through her research into the effects of smoking on health, such as cardiovascular disease and lung cancer.

Maab's overall objective within her project was to design a smoking cessation strategy for the Department of Health and Social Care to target at young people. She carried out a survey on young people's attitudes towards smoking and stopping smoking, as well as engagement with different types of public health messaging.

Maab found that social media was where her participants were more likely to access information from, particularly from video platforms such as TikTok, YouTube and Instagram. TikTok was the most popular platform amongst her participants and based upon this evidence she concluded that the Department of Health and Social Care should post TikTok videos in order to reach the potential of young people's engagement in smoking cessation campaigns.

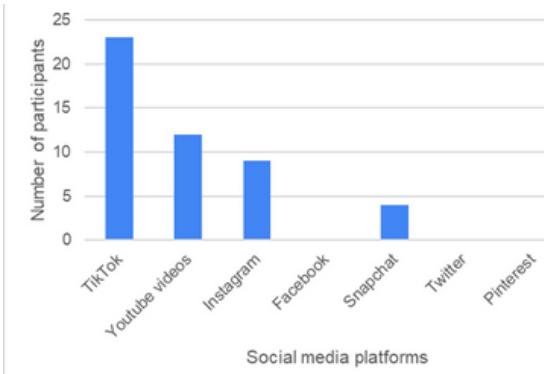


Figure 2. preferred social media channels for young people

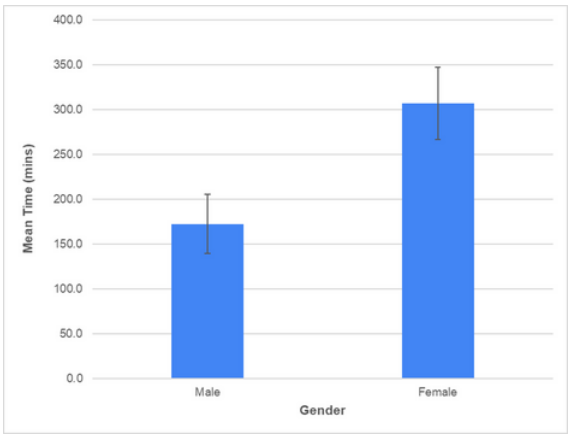


Figure 3. Mean time per day spent on social media

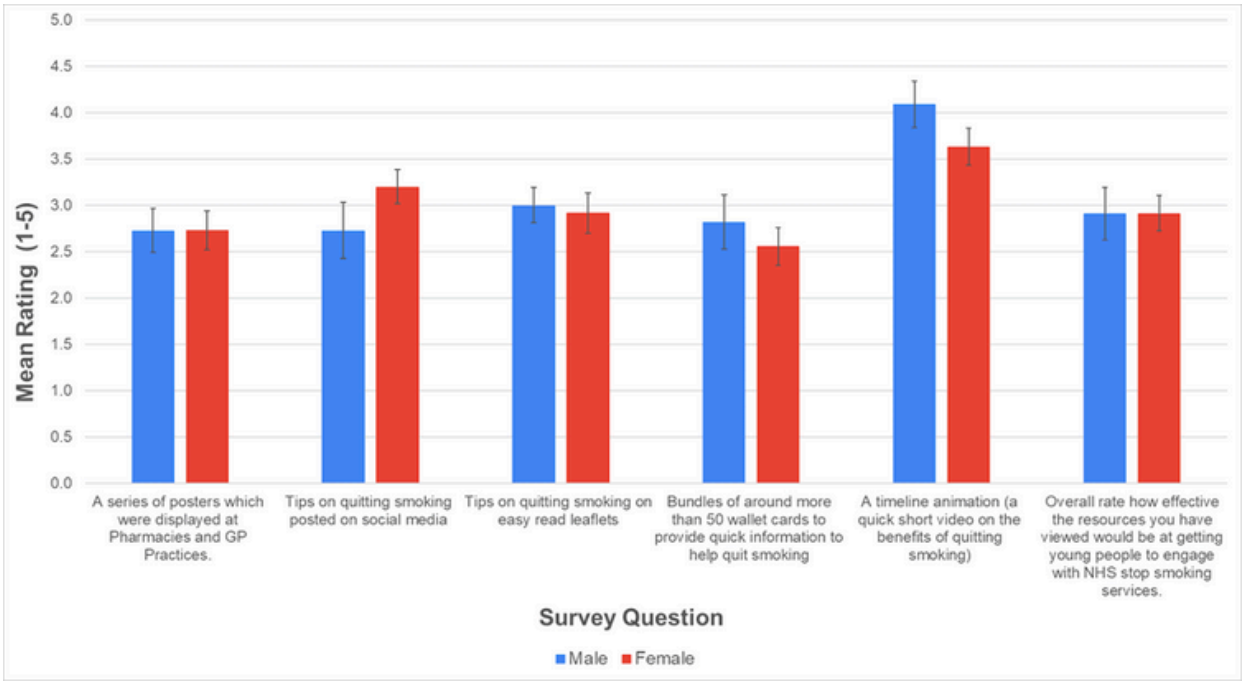


Figure 4. Mean ratings of types of smoking cessation campaign on likelihood to engage respondents

Maab's analysis of her survey suggested that young people tended to report that they found that animations and short videos were the most effective types of media. These were preferred to posters and leaflets and the respondents suggested they were more likely to encourage them to engage in smoking cessation services.

These results together suggest some clear directions for future smoking cessation and other types of public health campaigns that wish to engage young people. Short videos or animations that are targeted to social media channels such as TikTok, YouTube and Instagram are likely to be the most effective strategy. On average the young people surveyed were spending well over 3 hours per day on social media. This combined with the clear preference for short videos and animations provides a good case for focussing developing these type of marketing campaigns for popular social media channels that young people regularly access.

Figure 5. example of existing poster based approach found to not be as engaging for young people

Personally, I found Maab's EPQ to be hugely relevant to our society today. Although the number of young people who smoke in the UK has fallen, these are most likely turning to alternatives such as vaping which is constantly increasing amongst youth. So it is vital that the government does as much as it can to intervene and prevent more young people from participating in smoking and jeopardising their health.

Original research by Maab Ewad
Edited by Annie Knowles

Maab is currently preparing to apply for medicine. Good luck Maab.

Future Editions

In the next edition of the the journal published by the Baltic Research Institute we have our eyes set on including a larger variety of STEM subjects. We are hoping this will attract a larger audience of those who will read the journal as we the current edition of the journal has been largely focused on science. The journal is commited to showcasing the research conducted by students working in the Baltic Ressearch Institute and across the schools in the Northern School's Trust. By broadening our focus to include all of the STEM subjects, we will allow for more of the hard work students are carrying out to be showcased through this journal and appeal to a wider spectrum of readers. We are currently aiming for the next journal to be out by Easter and you can expect us to cover a range of fascinating research projects all carried out by students in the Baltic Research Institute .

BRI Social Media and Podcast

We are currently in the process of expanding our outreach. This will take us a while so please be patient. We hope to develop our website and socials so that you will be able to find all of our work, at the Baltic Research Institute, online. In the coming months you can expect a Baltic Research Institute podcast presented by the students working in the BRI. This will provide a deeper insight into the research faetured in the journal and the people behind it. We will interview a large variety of people including student researchers, establshed academics, employer partners and many more. In the mean time, we hope you have enjoyed reading this latest edition as much as we've enjoyed putting it together. We always welcome constructive feedback and would love to hear from you if you would like to collaborate. Thank you for reading.

Merry Christmas and a Happy New Year!

from **Charlie Baden**, **Henry Gorst** and all at the Baltic Research Institute

BRI

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