



GLOBAL BIOMEDICAL ENGINEERING TRAINING:
WORLDWIDE ACCESS TO
WORLD-CHANGING SKILLS





**Medical Aid
International**

Supporting Healthcare in Low Resource Environments



Contents

Introduction	4
What is Biomedical Engineering? Who is the Engineer?	6
What is the Reality? Why this Programme?	6
How does the Biomedical Engineering Programme Work?	8
The Course Content	10
Helping you Identify the Right People	12
Who is Best Placed to Benefit? Student Selection Criteria	13
Who is Suitable?	13
Person Characteristics	14
Candidate Application Process	15
Our Comprehensive Reporting System	16
Equipment Case Studies	20
Supporting Our Students	22
Biomedical Engineers: Motivated, Committed, Upskilled	24
Research Opportunities	26
Equipment Surveys and More: Key Benefits of Networking	27
Budget	28
Summary	29
Medical Aid International: More About Us	30
Medical Aid International: Tim Beacon, CEO	30
Engineering Innovation for LMIC Regions	31
What You Can Do Next	31



Introduction

All of us who work in the aid sector want to deliver services that are suitable, effective, value for money, and relevant for the environment and people we serve. We all know that the provision of such services requires support in many forms, but with the varying challenges faced on a daily basis in all of our work, we must often strive to find innovative ways of achieving our objectives.

Most recently, COVID-19 placed significant additional pressure on these processes. It did, however, present opportunities for us to explore alternative ways of working that have delivered benefits, not only during COVID-19, but also beyond it.

Take our Biomedical Engineering Training Programme, for example, which is the subject of this document. Having run residential training courses for a wide variety of organisations, we knew that this programme was vital in enabling healthcare institutions in LMICs (Low and Middle Income Countries) to keep their equipment functioning better, and more safely, for longer.

Whilst incredibly effective, such courses were comparatively expensive, and therefore accessible to fewer support staff than we would like; they also became unworkable once the COVID-19 restrictions on travel and social contact came into effect.

This is just one more reason why we have realised our vision of providing global access to effective

biomedical engineering training. The foundational knowledge provided through engaging video content online is a holistic package that can be used on its own or as part of a wider support strategy, with no travel or face-to-face tuition required.

The impact of our Online Biomedical Engineering Programme cannot be overstated. It is clear and demonstrable; below is a quote from a master's student who evaluated our course as a research project. It perfectly sums up the key role our course plays in LMICs.

The **feedback on the course has been incredible...** all the interviewees have been eager to share anecdotes about their experiences working in low resource hospitals, how **formal university education is not preparing them** for their roles in the hospital, and how **challenging it is to provide user-training** to hospital staff when **they themselves have never been trained** on the equipment...

[There is a] **significant role Medical Aid International** is playing by providing a **course that fills the void** left by insufficient local education and neglect of duty by equipment manufactures/supplies.

Master's Level Research Student



I managed to fix a blocked suction machine from my... dental surgery yesterday, and [I] am yet to fix another suction machine which has a broken drainage system by replacing it with other material I will get from hardware stores... [I] am also working together with engineers at our district hospital to familiarize myself with practical fixing of medical equipment.

The course is life changing.

I was not able to fix these [surgical] diathermies [ESUs] because I didn't know how one can go about troubleshooting them. But with the coming of Medical Aid International I was able to fix some, and even yesterday we did a fix one again and some other machines as well, we are able to work on them.



The student in question repairing the suction machine.



The joy of being believed in.

What is Biomedical Engineering? Who is the Engineer?

What is the Reality? Why this Programme?

Definitions and answers to these questions vary considerably, depending on the context. In more developed settings the role tends to be more tightly defined, with engineers specialising in very specific areas and generalisation being less common than it once was.

In LMIC environments this is very rarely the case. Maintenance, if the concept exists, and repairs are often done by 'fixers', whoever that may be. Often repairs simply fall to someone who has a natural inclination to repair things, or by default it goes to someone who looks after the property. Often that very person will have little or no knowledge and often very few tools.

Yet in our 20 years of experience, it has become clear to us that the 'fixers' often have great knowledge and passion. They also respond very positively to the local teaching we give them when on site carrying out installations. They want to make a difference and are frustrated that they cannot.

Medical Aid International's CEO, Tim Beacon, has a medical; educational and personal development; and organisation consultancy background; and was determined to do something about this. Initially Medical Aid International started running eight week residential courses for Mercy Ships, supplying education, consultancy and accompanying infrastructure aspects. However, it became clear that whilst these were very successful, it was not a cost effective way of working, in terms of delivering to a global audience.

From this, the online programme was born. Holistic in nature, it includes a professional tool kit, textbooks, and an electronic library of service manuals. The course content reflects the unique needs of the LMIC environment and includes context appropriate first aid, train the trainer and first line fault finding aspects.

The course content reflects the unique needs of the LMIC environment and includes context appropriate first aid, train the trainer, and first line fault finding training.



Aggrey in Kenya, after he had completed the online course, using his toolkit, including headtorch, to install an operating light we sent.



The light working.



We wanted this programme to be relevant in both major cities and the most remote rural environment.

Tim Beacon, CEO, Medical Aid International



How does the Biomedical Engineering Programme Work?

The training is designed to be simple to implement and monitor. The programme is delivered entirely online, so can be accessed and completed from anywhere in the world; it is available in both English and French.

There are 15 units, and at the end of each unit there is a series of multiple-choice questions (MCQs), totalling 300 over the entire programme. The student must achieve 100% in order to move on to the next unit.

Students can retake as many times as necessary, but each time the questions and answers shuffle, to ensure genuine understanding and robust learning.

The programme also includes:

- A comprehensive professional engineering toolkit
- Four textbooks
- A digital library of service manuals
- Professional workplace clothing
- City & Guilds certification, with a framed certificate shipped to a nominated address
- Reporting tools to enable sponsors and team leaders to track and support their students' progress
- A laptop in a protective case (a highly recommended optional extra)

By providing all the necessary resources required for our Biomedical Engineers to do their jobs effectively, in particular the professional grade toolkit, we ensure a positive day-to-day impact from our programme.

To increase the reach of the course, and allow a greater number of students access to it, we made the course available in both English and French.

Professional toolkit and textbooks – all supplied as part of the training programme, with optional laptop in a protective case.



“

This is the one [toolkit] which is helping us a lot because we have a deficiency in the working tools. So, with the coming of these tool kits, we are able to move around to work within the hospital. We don't have any problem in terms of tools.

”





The Course Content

The course content, available in both English and French, covers the many relevant and vital topics that will give students the basic foundations of biomedical engineering knowledge, including:

- Health & Safety
- Electrical Safety
- The Frequency Spectrum
- Electrocardiogram (ECG)
- Defibrillation
- Patient Monitoring
- Infusion Devices
- Premature Baby Incubators (PBIs)
- Ultrasound
- Surgical Diathermy/ESU
- Hygiene Guidelines – with COVID-19 Updates
- Anaesthetics and all aspects of the Operating Department – includes Oxygen Concentrators
 - First Aid
 - Train the Trainer
- The X-ray Department
- The Hospital Laboratory
- Principles of Fault Finding
- COVID-19 Guidance across all Subject Areas



Upon completion of the course, the candidates who pass will receive an Assured Biomedical Engineering certificate from City & Guilds – a globally recognised awarding body.

Each unit has been carefully crafted to reflect the realities of the LMIC environment, and offering tangible, easy to implement solutions that make a huge difference.



Unit 0 (Health & Safety) This unit has helped me a lot, as biomedical engineer, we frequently work on dirty machines which normally carry pathogens, this unit outlines the safety procedures that, as engineers, we must follow to avoid cross contamination from the machine to an engineer.

Unit 2 (Electrical Safety) This unit outlines the electric safety procedures, as biomedical engineers, we frequently work with machines that needs electricity to power them, the electric safety procedures outlined in this unit are beneficial and it will prevent the occurrence of accidents, for example fire, electrocution in the hospital as well as in the workshop.



Helping you Identify the Right People

As long as the student can read and write in either English or French and has basic numeracy skills, they can successfully complete the programme. What is absolutely essential is that the student is enthusiastic, passionate and motivated. In our experience, apparent prior knowledge is not always reflected in the student's learning.



“

I greatly appreciate you Medical Aid International for the program you offer and a simple demonstration of the course which makes easy to understand we have learned a lot it might be hard to explain almost everything. Most questions I had concerning medical equipment has be answered. They will be great improvement from now. THANK YOU VERY MUCH KEEP IT UP.

”

“

OK, so my interactions with the doctors and the nurses has always been OK, so it's been good. But I think after the Medaid course it has improved because I have gotten a deeper understanding into how the machine works... and then so when I meet this doctors and nurses, I am able to confidently explain to them what's going on with the machine.

”

Who is Best Placed to Benefit? Student Selection Criteria

Investing time, energy, and resources into developing Biomedical Engineering services is key to ensuring the long-term sustainability of healthcare projects. This vital area of infrastructure support should be developed strategically, using a holistic approach.

It is essential that the correct people are identified to undertake the online course. Below we have outlined some ideas as to how to approach the selection process, based on many years' experience in leadership, personal development, education, teaching, and consultancy.

Who is Suitable?

Our current data clearly demonstrates the following:

Whilst a background in biomedical engineering, electrical maintenance, plumbing and car mechanics can clearly be an asset, it does not mean that someone without these qualifications or this experience will be any less successful after completing the course.

General “fixers/estates managers” can complete the course as quickly as a person with more qualifications and can be just as competent and effective afterwards. In our experience, people with this background have often acquired extensive knowledge through necessity; it is this already developed mindset and skillset that makes them such good students and potential engineers.

Person Characteristics

Our experience shows that the following are important characteristics of person specification, both in order to complete the course and also to go on to be effective engineers:

1. A good level of reading, writing and basic arithmetic.
 2. Ideally experience in the healthcare sector; if they do not have this some pre-course familiarisation would be beneficial.
 3. Passion and enthusiasm to make a difference.
 4. A proactive, positive thinking, problem solving outlook with the ability to be a team player locally and nationally.
 5. Has the potential to benefit from the communication aspect of the training.
 6. Determination and tenacity.
 7. The ability to organise themselves.
- 

Candidate Application Process

As part of the selection process, it may be advisable to have students apply for the places. Given that local protocols will apply, different methods may be better suited in each case; it is our suggestion that the selection process could involve some, or all, of the following:

1. An application form. Personal statements and CVs can be helpful but some of the candidates may be unused to this format, putting them at an unnecessary disadvantage.
2. Two references including one from the student's direct manager. Our suggestion would be these are both written and verbal.
3. An interview. We recommend the students give a short, verbal presentation, that is not PowerPoint based. We suggest this isn't on a technical subject but on something that interests the student, and that they are comfortable talking about. This allows the interviewer to get a more in depth understanding of the candidate and their personality.
4. If it is possible, arrange to meet students informally in the workplace. This more relaxed environment gives the interviewer an opportunity to get to know each student more thoroughly.



Our Comprehensive Reporting System

To help support our students and partners, Medical Aid International provides a comprehensive reporting system as part of our Biomedical Engineering Course, including:

- Weekly or fortnightly progress reports
- A bespoke data analysis report: analysing student programme feedback and investigating the impact of the programme
- Student survey data that details the impact of the course
- Student enrolment management and support
- Access to all student data for the coordination group



Our progress reports consist of 4 key sections:

1. Group overview, showing a snapshot of student progress.

8 of 8 Students Complete

Average Time To Complete - 19:41:03

Group Overview

ID	Name	Completion Date	% Complete	% Complete Last Week	% Change	Time To Complete	Time Spent	Total Time Before	Time This Week	Time Last Week
#1	Student 1	27th November 2022 10:06 am	100	↑ ↑	100%	0%	19:33:00	20:25:15	20:25:15	0:00:00
#2	Student 2	2nd October 2022 11:53 pm	100	↑ ↑	100%	0%	14:03:45	16:13:00	16:13:00	0:00:00
#3	Student 3	11th November 2022 2:04 pm	100	↑ ↑	100%	0%	28:18:15	28:33:15	28:33:15	0:00:00
#4	Student 4	11th October 2022 8:06 pm	100	↑ ↑	100%	0%	17:44:45	18:14:45	18:14:45	0:00:00
#5	Student 5	30th September 2022 10:00 pm	100	↑ ↑	100%	0%	16:26:45	16:28:15	16:28:15	0:00:00
#6	Student 6	27th November 2022 10:30 pm	100	↑ ↑	100%	0%	15:28:00	15:29:45	15:29:45	0:00:00
#7	Student 7	3rd February 2023 6:12 pm	100	↑ ↑	100%	0%	23:00:30	23:01:30	23:01:30	0:00:00
#8	Student 8	15th December 2022 1:44 pm	100	↑ ↑	100%	0%	22:53:30	22:59:45	22:59:45	0:00:00

2. Progress tracker, showing past progress.

Previous Progress

% Increase	0%
13.02.23 - Average % Complete	100%
06.02.23 - Average % Last Week	100%
30.01.23	99%
23.01.23	99%
16.01.23	98%
09.01.23	96%
01.01.23	95%
26.12.22	93%
19.12.22	93%
12.12.22	85%
05.12.22	85%
28.11.22	76%
21.11.22	70%
13.11.22	70%
06.11.22	0%

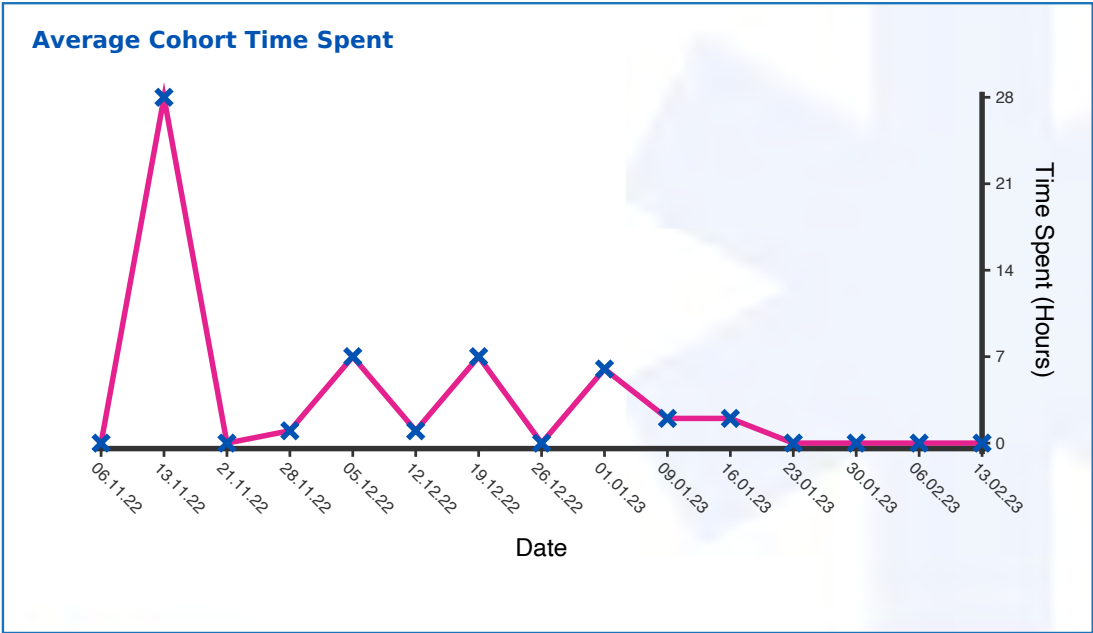
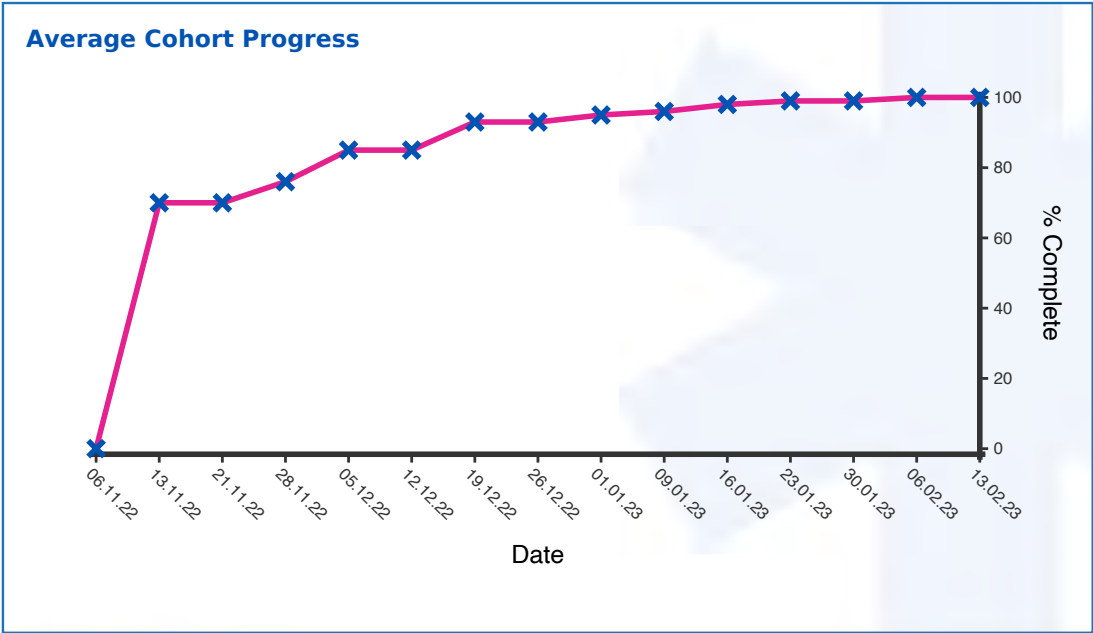
Previous Time Spent

Average Time (Completed Students)	0:00:00
Average Time Last Week (Completed Students)	0:05:26

% Time Increase	0%
13.02.23 - Average Time (Unfinished)	0:00:00
06.02.23 - Average Time Last Week (Unfinished)	0:00:00
30.01.23	0:35:15
23.01.23	0:52:45
16.01.23	2:30:00
09.01.23	2:45:15
01.01.23	6:24:45
26.12.22	0:00:00
19.12.22	5:59:15
12.12.22	1:22:00
05.12.22	7:25:15
28.11.22	1:17:30
21.11.22	0:00:00
13.11.22	9:05:00
06.11.22	0:00:00



3. Progress graphics, allowing progress information to be easily understood.



4. Individual progress, showing the MCQ results for each student.

Group Members

Student 1

Working on Module 17 of 17 - Time to Complete 19:33:00

Test Name - Student 1	Score	Date Completed
Unit 0 - Health and Safety MCQ	50	10th October 2022 1:39 pm
Unit 0 - Health and Safety MCQ	66	10th October 2022 1:47 pm
Unit 0 - Health and Safety MCQ	91	10th October 2022 1:51 pm
Unit 0 - Health and Safety MCQ	100	10th October 2022 1:53 pm
Unit 01 - The Frequency Spectrum MCQ	60	10th October 2022 3:13 pm
Unit 01 - The Frequency Spectrum MCQ	60	10th October 2022 3:20 pm
Unit 01 - The Frequency Spectrum MCQ	90	10th October 2022 3:28 pm
Unit 01 - The Frequency Spectrum MCQ	100	10th October 2022 3:37 pm
Unit 02 - Electrical Safety MCQ	45	11th October 2022 9:22 am
Unit 02 - Electrical Safety MCQ	95	11th October 2022 9:52 am
Unit 02 - Electrical Safety MCQ	100	11th October 2022 10:24 am
Unit 03 - Electrocardiogram MCQ	48	11th October 2022 3:00 pm
Unit 03 - Electrocardiogram MCQ	100	11th October 2022 3:26 pm
Unit 04 - Defibrillation MCQ	72	12th October 2022 4:44 pm
Unit 04 - Defibrillation MCQ	81	12th October 2022 4:47 pm
Unit 04 - Defibrillation MCQ	90	12th October 2022 4:55 pm
Unit 04 - Defibrillation MCQ	81	12th October 2022 4:58 pm



For WFSA, partnering with MAI has been a real plus. Not only are they experts in providing appropriate equipment for low resource environments, but their biomedical engineering courses address the essential skills needed to keep that equipment functioning properly. And we've been kept updated on students' progress via regular progress reports and self-evaluations so we know where our investment is going. By supporting these courses we are making anaesthesia and surgery safer.

Head of Head of Development, World Federation of Societies of Anaesthesiologists

Equipment Case Studies

Whilst our course primarily consists of theoretical content, it also offers practical guidance for students. Our course theory focuses on the safe operation of a wide variety of medical devices. Building on these fundamental principles, our students learn how to troubleshoot and maintain equipment in a safe manner.

By providing these vital services, our graduates help their healthcare facilities save money on

replacement equipment. Funds often don't allow for the purchase of replacement equipment; without this ability, patient care would be compromised. Below are some examples of machines which have been repaired or maintained using knowledge from our Biomedical Engineering Course.

Approximately one third of the machines fixed by our course graduates used knowledge from our Biomedical Engineering Course, according to a 2023 student survey.



- Autoclave/steriliser with a faulty temperature sensor
- Circuit analysis allowed a repair of the temperature sensor to be undertaken
- Knowledge was obtained through textbooks provided by Medical Aid International



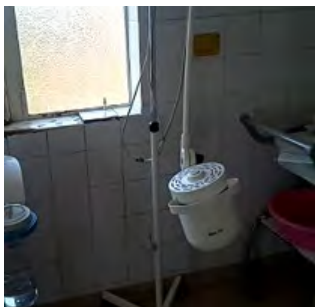
- Maintenance conducted on an infant incubator
- Incubator was cleaned and the air filter replaced
- Temperature reading of the incubator was also verified by checking against a thermometer placed inside the incubator



- Autoclave/steriliser would not turn on
- Graduate replaced the fuse of the machine, restoring full functionality



- Pulse oximeter would not display health parameters
- Patient probes replaced, allowing the pulse oximeter to function normally



- Operating light had not been working for six months
- Upon inspection, student realised a capacitor on the circuit board was faulty
- Fixed by replacing it with a capacitor from a piece of obsolete equipment

Evidently, our course graduates play a vital role across healthcare facilities in the provision of an efficient and effective biomedical engineering service. This is key to tackling the challenge of equipment graveyards, while facilitating capacity building and improvements to patient care.

Supporting Our Students

Using the data contained in the weekly updates, students can be motivated and encouraged accordingly. They also help to identify any students who might need additional support to complete the course, such as providing internet access or helping them set aside time for this valuable training.

The data contained within the weekly reports can also be accessed in real time by the course coordinator(s). Guidance and training can be offered to help the coordination team interpret the data.

After all students in the cohort have completed the course, a bespoke data analysis report is written that reflects the unique performance, characteristics, and feedback from the group. This tailored approach allows for detailed insights to be uncovered.

A small selection of data taken from one such data analysis report is shown opposite. The graphs on the right exemplify the type of data analysis provided in the bespoke data analysis report.

This real-world data contained in the bespoke data analysis reports demonstrates how vast an impact this course has on students and the clear benefits for everyone who completes the course.



*Biomedical engineer:
motivated, fully equipped,
and ready to start training.*

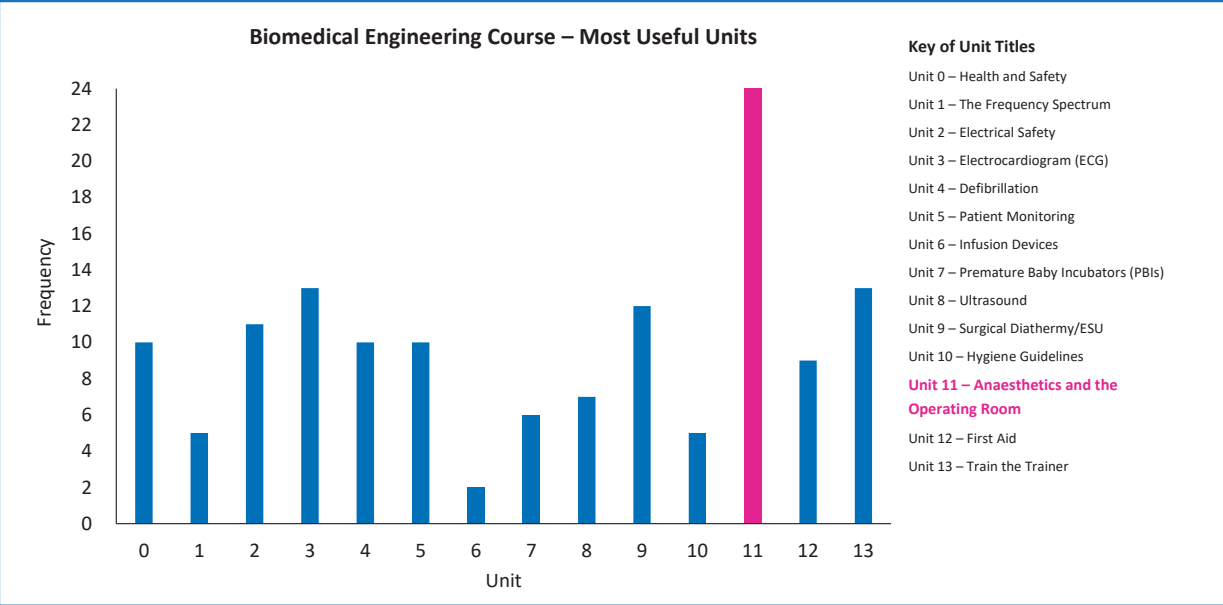


Fig.1 The figure shows that students found Unit 11, Anaesthetics and the Operating Room, the most useful unit. This likely reflects the need for a better equipped operating room.

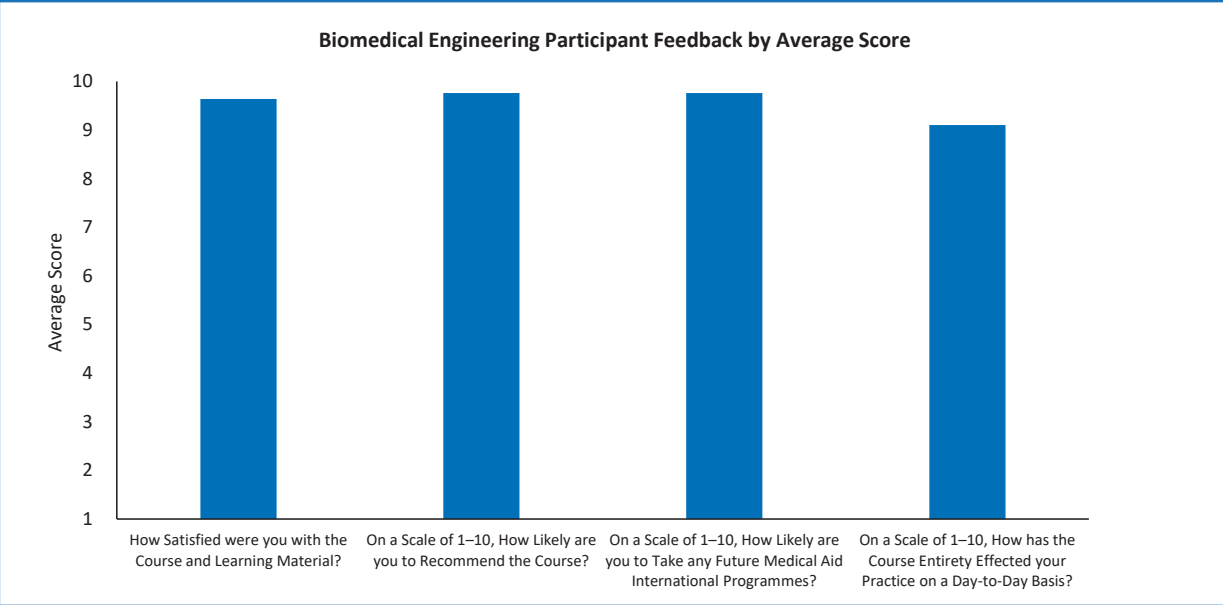


Fig.2 The figure highlights the fact that students reflected very positively across all aspects of our Biomedical Engineering course.

Biomedical Engineers: Motivated, Committed, Upskilled

This programme is about more than just technical skills, knowledge and tools. It is the people who are at the core of what we deliver, and why.

So often in our work, we have met ill-equipped but nonetheless motivated hospital maintenance staff and engineers. When we worked with them, it was wonderful to see them grow in stature as they enthusiastically assisted and learned from us.

Our experience is that the engineers, when trained and equipped appropriately, radiate a confidence that is then reflected in their day-to-day work. This, in turn, inspires the people they support, exerting a significant positive influence on clinical outcomes.

This is why our Biomedical Engineering Programme has an entire unit dedicated to the “Train the Trainer” approach. By harnessing and supporting the confidence of the Biomedical Engineer, as well as developing their ability to train others, we can create a network of motivated technical personnel across any given country, with transferable skills that can also be applied to general communication and support across other projects.

The benefits of upskilling already motivated and committed engineers can therefore not be overestimated.



Unit 13 (Train the Trainer) This unit has helped me realize the importance of communication. Indeed, my ability to interact well and professionally with others will mean that they are more likely to listen to my opinion, have more confidence in me and involve me in decisions moving forward.



The real world impact of our Biomedical Engineering Course.



Our trainee Callixte at Madagascar's CHUT medical facility. Our assessment visit revealed a lack of training, tools, and professional confidence.



Callixte, post-course, with the City & Guilds certificate awarded through our Biomedical Engineering Training Programme. Proud, fully trained, self-confident, he is now part of a motivated team properly equipped with a full comprehensive toolkit to provide long-term support.

A quote from one of our graduates, demonstrating that building confidence is just as important as developing skills to effect real world change.

“

So, with the Medical Aid training, my objective was to build confidence and skill and all the while improve patient care. That was why I set out to do when I started the course. Indeed, after the training, I can say when I go for my morning check, talking to the users and nurses and doctors. I'm more confident just interacting with them, letting them know that I am here for you. Just let me know how we can together make sure equipments are available for you. So I'm building it. I'm building it.

”

Research Opportunities

Another benefit of running our Online Biomedical Engineering Course is the opportunity to network with frontline staff on-the-ground. Once trained using our course, these Biomedical Engineers can provide valuable insights into your healthcare facilities and highlight areas where challenges are most present.

We have also been involved with research at a master's level, where our course was evaluated as part of a wider investigation into the standard of biomedical engineering training in LMICs. The result was a glowing review of our course: "[it] fills the void left by insufficient local education and the minimal to no after-sales support".



The feedback on the course has been incredible, which has made the evaluation aspect of the dissertation a little difficult! In addition to answering my questions regarding the course, all the interviewees have been eager to share anecdotes about their experiences working in low resource hospitals, how formal university education is not preparing them for their roles in the hospital, and how challenging it is to provide user-training to hospital staff when they themselves have never been trained on the equipment. Thus, my dissertation is shifting to a critical analysis of the current state of health technologies and biomedical engineering in LMIC (with a focus on Ghana, Malawi, and Zambia) and the significant role Medical Aid International is playing by providing a course that fills the void left by insufficient local education and the minimal to no after-sales support.

Master's Level Research Student

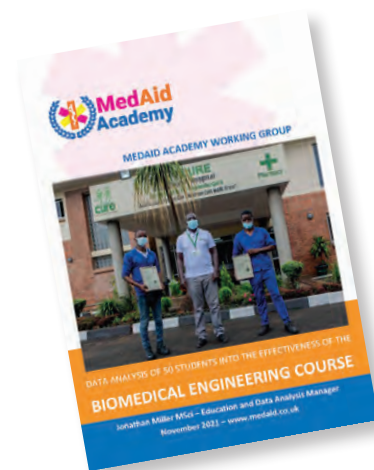


Equipment Surveys and More: Key Benefits of Networking

A great example of the fruits of this networking and research is our latest Operating Room Equipment Studies. Utilising our existing network of trained Biomedical Engineers, we were able to facilitate a survey of 75 operating rooms across seven LMICs.

We have also conducted research into the effectiveness of our Biomedical Engineering course. In short, the course is extremely highly rated, with students giving the course 9.64/10 for course satisfaction.

You can read each of the reports by scanning the QR codes below:



Budget

We suggest, if funds are available, that students are provided with the optional laptop and protective case that we can supply. This combination will enable students to follow the course, research solutions in their role as Biomedical Engineers, and communicate easily with project coordinators both directly and through internal forums (e.g. Microsoft Teams).

The Biomedical Engineering Programme (without a laptop) costs £2,000 per student, plus freight (volume discounts apply). This includes:

- The online programme
- A comprehensive, professional engineering toolkit
- Textbooks
- A digital library of service manuals
- Professional workplace clothing
- City & Guilds certification, with a framed certificate shipped to a nominated address
- Reporting tools to enable sponsors and team leaders to track and support their students' progress

We also offer the option to order the online biomedical engineering content only (with no additional resources), at a reduced rate of £650 per student (volume discounts apply).

For course pricing with a laptop, please contact our CEO, Tim Beacon, at tim@medaid.co.uk.

Medical Aid International can also provide consultancy on the provision of an effective and efficient Biomedical Engineering service.



The comprehensive, professional toolkit and textbooks.

Summary

At Medical Aid International, we are passionate about delivering efficient, value-for-money training that empowers LMIC healthcare communities and enables them to proudly and confidently take ownership of their patients' current and future treatment and wellbeing.

Our online Biomedical Engineering Training Programme model is effective, simple, quick to implement, and proven to benefit patients rapidly. It means equipment keeps working, treatment keeps going, and patients keep recovering.



Working in partnership with biomedical engineers, Uganda.

Medical Aid International

More About Us

Medical Aid International is a long-established, UK based, successful Social Enterprise with a culture of delivering effective healthcare solutions.

Alongside our work of equipping healthcare facilities in LMICs, we have always had an underlying belief in the value of education that is truly relevant to the environment and people it is delivered to – hence our development of the online Biomedical Engineering Training Programme.

Tim Beacon, CEO



Tim, the CEO of Medical Aid International, has a clinical and commercial background in orthopaedic trauma and is also a qualified teacher who taught for several years in the UK NHS and university-based nursing schools.

Tim is an ambassador of the Primary Trauma Care Foundation, having directed numerous programmes, and supported multiple research initiatives. He was also a part-time instructor on the UK military special forces medical training course for five years and has completed the Oxford University Anaesthesia in Developing Countries course.

He ran an adventure training-based personal development company for healthcare staff for 20 years, in addition to a church leadership role.

It was Tim's extensive training and education background that led him to consider more innovative ways of teaching, and it was this reflective process that inspired the team at Medical Aid International to put together a Biomedical Engineering Training Programme that could be followed online by anyone, anywhere across LMICs and, indeed, the wider world.

Engineering Innovation for LMIC Regions

We are innovative and lateral-thinking in our approach, to the point where we have even designed and built our own LMIC-appropriate medical solutions where none previously existed. These include the EcoClave™ wood-fuelled autoclave, and, in partnership with a major UK university, an LMIC-friendly CPAP device that is currently undergoing clinical trials.

We are also at an advanced stage of development of producing a British made, low cost external fixation system, specifically designed for LMIC use.

What You Can Do Next

Our Biomedical Engineering Training Programme is helping to create real change for the better in hospitals and healthcare facilities in LMIC regions, and why we're proud of it.

Why not take the next step and find out more?



- **Visit our online training web page.**



- **See what engineers help maintain:** the healthcare solutions that change and save lives.



- **Get in touch:** ask us how our online Biomedical Engineering Training can help your work.



*The real world impact
of our Biomedical
Engineering Course.*

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