Transcript of Cherrybrook Technology High School STEM Connection reflection

Melanie Hughes with Yetsum Yang (Science), Eddie Woo (Mathematics), George An (Science)

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Introduction: In 2015, ACARA conducted the STEM Connections project to investigate the effectiveness of using an integrated approach to the teaching and learning of STEM disciplines. In this podcast, we interview teachers five years after their involvement in the project.

Melanie Hughes, Senior Project Officer for ACARA's Digital Technologies in focus project, interviews Yetsum Yang, Eddie Woo and George An to discuss the lasting effects of the STEM Connections project at Cherrybrook Technology High School.

Melanie: I'm Melanie Hughes, project officer with the Digital Technologies in focus project at ACARA, and I'm here at Cherrybrook Technology High to talk to three of the teachers involved in the STEM Connections project: Yetsum Yang, Eddie Woo and George An, and I will have them introduce themselves to you now and talk a little bit about what they do here at the school and how they were involved in the project.

Yetsum: I'm Yetsum Yang, I'm a science teacher by training. I'm trained in physics, maths and chemistry, and we got involved in the first project that is the playground.

Eddie: My name is Eddie Woo. I teach Mathematics here at Cherrybrook Technology High School and it was my first year at the school actually when this first project was tabled and our deputy principal said to us, 'Look, we want to put together a team for this. We want to have representation across all the discipline areas', and we also wanted a project which was relevant to our students and therefore the huge growth of the school from an original campus design of 800 students up to a current enrolment of about 2000 seemed like a really fitting context for a project to think about how we redesign our playground. So that was my involvement.

George: My name is George An. I've been at this school for seven years now or just over and I'm a science teacher, I teach Physics, and we'd been invited to participate in this program I think in 2014 and 2015 was the implementation.

Melanie: What happened after the project finished? Did the project continue and if it did how did it continue? Was it the same or different and if it didn't, what were the things that maybe stopped that from happening?

George: I believe this project continued for one more year after our project. Initially we invited students and so we picked the students that would be in the class so we knew that they were pretty good at science, pretty good at mathematics and

generally had an interest in the STEM field and that was the initial project to kind of reduce the variability of student interest and potential behavioural issues.

So that was the first year. It went really well. We had a lot of interest from the community, from external parties as well, and so I think that project ended quite well; however, in terms of the sustainability, I would say it was very limited because when we repeated the exact same project, students had already talked to other students about it. There were only so many things we could do in terms of redesigning the top playground, in terms of it actually eventuating was almost zero per cent as the school already had some plans in itself to redesign the top playground. The biggest hurdle would have been the finance side of things in terms of funding the ideas that the students had. They were all really good ideas. But in terms of sustainability I'd say it was quite short lived.

As to why it was short lived, there were multiple factors, not just one cause of it. The biggest contributing factor of it not sustaining was the staff. So we had, I think it was Alesha Bleakley; she left for a different position and then Eddie, Yetsum and I, we went into different roles and became less involved as STEM started to grow, I would say exponentially in the school, it became less manageable and we had this philosophy of STEM for all as opposed to STEM for specific students and with that philosophy came its challenges in terms of students' interests, student behavioural issues, which I can talk about later. But those were the two main contributing factors as to why it was not sustainable.

Eddie: That was definitely when we first began a conscious awareness for most of us, certainly me, that this was us breaking new ground as teachers and we were quite happy to give that experiment a go and to say, 'Look, we're anticipating that this is going to be something which is going to change and mould as we go', and for us to say, 'Look, this project in its existing form is just going to keep on going all the way through', in some ways wouldn't have been the transformation we were all looking for.

Something we've all discussed over the last few years as the STEM project has … it's expanded and shifted and it has definitely grown. We have so many students who in the first year were quite upset they couldn't be involved and even in subsequent years when we opened it out we could never… We had a lot of difficulty staffing the number of students, the amount of interest there was. We thought, *Well that's certainly a good sign that people are getting from word of mouth from their peers, from siblings. This is a really interesting way of learning. It's different to the other electives that are available.* And certainly at a school like Cherrybrook, which is unusual because of the semesterised way that we run electives in Stage 5 ... students, every six months, they are trying out something new. It's one of the best things about a school of our scale is a wide variety of curriculum choices even in Years 9 and 10 and I think a lot of students really thought, *Wow, this is great! I can give this a bit of a taste and I've got nothing to lose* – and a lot of thought has been

put into designing something a little bit different… with that multi-teacher nature to the learning so in some ways that evolution of what STEM looked like at our school was a very natural thing to expect.

Yetsum: So from our first thing when we got involved all of us, the three teachers plus Alesha, it was a very good start and the students were then encouraged to join with their project. They joined an external competition and they won $300 for the school and I think that gave them a kind of … [they were] more willing to learn different skills that they can pick up from STEM and encourage them to take up, some of them, to take up science and maths, which is the positive.

On the other side, I do agree with George and Eddie that we have evolved from there and that we're trying to see what kind of program we can bring to the students to encourage their engagement and we are quite open to ideas in a way that we got different ideas from different teachers like what George has spoken [about] like 'STEM for all' and from there we were looking at whether we've got some positives and negatives we can learn from there. It's still a learning process for all of us, what can work and what cannot work that well for the students and we are still looking into our current programming for next year to see whether we are going to modify some of the activities that we have and the direction that we are going to take. So it's a learning experience, I would say, for everybody.

George: I just remembered as Eddie was speaking, the main reason why this project was not sustainable was because it wasn't the Board-approved program. That's the program that we were approved to teach at this school, not the one that we initially developed with ACARA, and so I believe it was a Department initiative. Someone created this program which as a part of the …

Yestum: … the STEM syllabus

George: Yes, STEM Stage 5 …

Yestum: It's the STEM Stage 5 STEM syllabus.

George: Yes, so it's the STEM Stage 5 syllabus that has been approved by the Board to be a 200-hour course for … a potential 200-hour course for the students. That's the one we approved, therefore we deviated from the original ACARA project.

Melanie: You mentioned that the project to design the playground, which was the focus of the original STEM Connections project, wasn't the sort of thing that you could carry on. Was the focus of the project changed to other things?

Eddie: One of the things that we originally had in mind was to make sure that we didn't just take something out of a box. It was very carefully designed and context specific. Actually, one of the things which I know we learnt most from a lot of the schools that were also involved in ACARA's initial project was how much power there is in giving students the opportunity to learn about and work on a project and

investigate an area that really has a personal connection to them and their community. So we saw that was something fairly consistent and so looking at our top playground, which, honestly, was was kind of a glaring problem for our school that when it's raining this topsoil just runs down into the lower part of the school and when its dry it's just a dust bowl. This was something that was so immediately obvious to all students. We want to fix this problem; it's related to Science, it's related to Mathematics, we can engineer a variety of different solutions for this. It just seemed a perfect fit for so many things.

But then what we started to realise was we had students who did the semester course but then remained interested in some kind of exploration of STEM and we thought, *Well, we can't make you redesign the playground again*, and we also had new staff who joined us who had experience and interest in a bunch of other projects which we knew could be a good fit. They had plenty of Mathematics and Science content in them as well, but these were more standard if you like, so solar vehicles, F1 in schools. These kinds of projects we knew had plenty of latitude to explore science and mathematics learning and integrate them successfully. But I guess we didn't want to start there because we knew – F1 in schools being a very good example of this – we didn't want to start off in a box with a whole series of exterior requirements around us that we didn't think were a good fit for us. We wanted to come to our own convictions about what we thought good STEM learning looked like in our context and then bring that to other readymade solutions. So that was part of how that progressed, even though we did take on those ideas in subsequent years.

Melanie: What changes have happened in the school context? Has there been any impact with the STEM learning? George spoke a little bit about how there was huge interest and a lot of students wanted to be part of the STEM projects and STEM learning going forward and you didn't have enough staff to make that happen and Eddie spoke a little more about that as well. I wonder, Yestum, could I ask you this question: What do you think have been some of the impacts, positive, negative or otherwise, of being involved in the STEM Connections project?

Yetsum: The positive impact I can see is more girls are interested. When we started at first we tried to have some girls joining in the STEM classes. But now we've got nearly, nearly maybe a third of them are girls, which is really a positive thing. They are more aware now. They are more ready to take on STEM courses hopefully in the future with the training in the STEM classes and the STEM experiences they have in the classroom. To me, that's really a big positive being a teacher who is also a woman. I'd really like to encourage especially girls to take up STEM work related career in the future and that's a really positive thing that I've seen and the numbers are actually growing as I can see, every year, more and more girls are enrolling into the STEM courses.

Melanie: That is a very big positive. Does anybody have any comment to make about why you think it is that the girls have found it interesting? Does it have

anything to do with it being a project that's related to their school and things that interest them or do you think there may be other things?

Eddie: As with all issues like this it's pretty complex and nuanced and there's so many factors feeding into this. Certainly when I spoke to a number of the girls who were in the classes that I taught, there was an attraction to the idea of, okay, this is a clear context in which mathematics or science or engineering can help me solve a problem that assists people. Now that's a very broad generalisation but it speaks to the fact that often, sadly, Mathematics and Science and Engineering sometimes are taught bereft from that context. And you can say, 'Why are we solving these equations? Why should I care about this particular formula?' Well, actually, it improves quality of life for a community to be able to give them a sustainable source of power or water or to be able to say this is going to make a decent impact on our carbon footprint, as a school. These are things which, having that kind of social impact front and centre in the way that you go through the design process, you think about who is going to be impacted by the project or the solution or the problem that you are encountering, and then you say, okay, now I'm going to bring knowledge in that interfaces with that. For me, that was one of the most strong attractions about learning the same content but in this different context that girls responded to really positively.

Melanie: How has your thinking about STEM changed?

George: When we first started briefing for this project in 2014 and subsequently I found it very difficult to get a definition of what STEM education was, and it's still quite ambiguous or can be ambiguous. As every school context might implement it a little bit differently; for example, if you have a maths-heavy teaching staff they might kind of take the maths angle.

Since I'm a science teacher, I inevitably have a science bias and it will be the same for a TAS teacher taking the engineering side. They'll have a TAS bias and so in that aspect the definition is still a little bit ambiguous for me personally as to what we're trying to achieve through STEM education.

Eddie: A lot of things over the last few years have changed for all of us. One of the key lessons I've taken away is that, when I first got invited/asked to be involved in this, like George, I didn't really have much experience with STEM as a fixed, well-defined idea, which is slightly ironic because I myself am trained as a mathematics and a computing studies teacher so that kind of project-based learning, I felt very comfortable in that world but I never thought deliberately. I was quite happy with them sitting in two areas of my brain and not interacting all that much except for when I had to teach software design students binary; that was the only time there seemed to be an overlap but it was quite superficial.

I transitioned away from thinking about STEM as, *Here is the thing we are focusing on delivering this program,* and among many other goals that it met for all of us, for

me the thing that stands out at the front of my mind is that STEM is more a means to an end. As teachers, for example, my time working particularly, not just in planning, but also *in* the classroom and watching my science colleagues and my TAS colleagues and seeing the way that they would approach. I'd think, *Oh, okay, we're going to be teaching the students this particular concept; this is the way I would teach it*, and like George says, we have our bias from our particular discipline and then I would see someone present a lesson that they had thought through on the same concept and deliver it in such a different way, and also even just interact with the kids incidentally in such a different way, and I don't think it's common in the vast majority of mainstream secondary schools for cross-KLA teaching to happen. Even within the KLAs, sometimes we are so time poor, it's very difficult to get into a colleague's classroom, and it was just mind-blowing for me. Literally, something that in some ways the more obvious it was to my science colleague talking to a kid that that's exactly the way I would answer that, the more surprising it was to me because that wasn't the first direction my brain went in and I thought, *Ha, this is not just changing my concept of how we teach this*; it actually changed the way I taught when I went back to my ordinary classroom because I realised, oh, there's a lot of science and a lot of engineering that I've not been aware of and lots of ways of thinking about this problem, design thinking is a classic example, which I didn't have the language for before but I realised I've sort of been in an underhanded way teaching parts of this incoherently to my students. Isn't this so much better having learnt from my colleagues to give them the whole picture and show that as the way I normally teach Mathematics, so that's been a huge benefit to me personally.

Melanie: Did you find yourself referring to the fact that you were part of a science lesson or you'd seen your colleague teaching to the students or was it just more conceptually that you were finding that you wanted to talk about those things?

Eddie: I think it was a it was a bit of both, and I certainly know, we all experienced this when we would walk particularly at the beginning of a year or a semester, we would walk in together, perhaps for the first time that we got timetabled on at the same time, and the students would be so weirded out. They were like, 'Mr Woo, what are you doing here? This is a science lesson!' And I'm like, 'Well, we are learning! Here we are all together', and it was great because it was a statement that we were embodying ourselves, as teachers, the fact that we want them to learn in a way that's collaborative, that blurs the disciplines together, so we want to illustrate what that looks like to you, as students, this is ... you have to lead by example. It wasn't easy to begin with because it really … put me out of my comfort zone. But in some ways, even more than the things we said explicitly, it was our collaboration in the classroom across KLAs that meant a lot to the kids.

George: Inevitably, without me even realising that through this STEM initiative at our school the way that my teaching and learning practices have definitely been influenced as a result of this. If we look at Mathematics and Science, they go hand in hand, but students don't see that. They get quite shocked when I talk about maths in

science lessons sometimes. I have introduced or tried to blur that line between science and maths. I'm not doing too well with engineering [laughs] and technology side of things but definitely between science and maths, it has impacted my teaching and learning.

Yetsum: I have changed in the way that I think the way I … [it was] a very steep learning curve for me and the students actually saw that I actually went to other teachers out of my faculty to learn things from them so that I can go to class and help them in their project or their work and I am all along very interested in art and design at the same time but I don't actually put that much into my area, I sort of teach science quite in an isolated kind of way. But now I've sort of bring that in you know you have this and we can have a little bit of maths in there when you do a little project with some paper or whatever. I bring a little bit of their art in there as well. It's like, how do you visualise this? I like to visualise things like 3D. I'm quite good at that but I never really built that into my lesson to get kids involved in that. I just leave them to do what they're comfortable with but now I'm trying to bring some of these ideas into the classroom as well when they do a science project. Maybe we should do a 3D model. Would you like to do that or would you like to draw a 2D model? I give them the options, if they're comfortable with it, whereas before that I'd maybe get that kind of worksheet from somewhere, modify it and maybe [it's] a bit isolated a way of thinking the whole class should be doing that in 2D instead of 3D because of the problem involved or whatever. I'm more prepared to change and accommodate the kids in terms of engaging them in their learning, so that's a plus for myself and I believe that's also a plus for the students in their learning.

Eddie: One of the key factors in the success of what we all got out of this and why the students wanted to do more STEM was that it's really crucial for a STEM project to have any measure of success, whether that is becoming an ongoing fixture in a school or changing the way science and engineering and maths are learnt … it's really critical, I'd go so far as to say it's kind of the prerequisite, it doesn't matter how fancy and flashy any of the other parts of the project are … you need to have teachers who are willing to engage as learners. And I thought that was really powerful for the kids to see, as Yetsum pointed out, 'Oh, okay, Ms, Sir, they're also learning things along with us', and it was a bit of a shock when when we did our evaluation of the project, the vast majority of the kids loved it. Some of them not so much, and when we drilled into that a little further, sometimes, not universally but often it was the kids who were the best traditionally at Mathematics or Science, and because this way of learning was so different and it required the embracing that, I don't know this and I'm going to have to find our way through this and there isn't just one clean answer and there isn't some time when it's just finished, because real life is not like that, that was a real wake-up call to me to say, okay, the success of these projects doesn't just depend on how you structure the timetable or who you get in as an industry connection; the choice of the teachers involved is critical in terms of well ... Is there a science teacher willing to learn some of that maths? Is there a maths

teacher willing to say, ‘Okay, I don't really know how the engineering works in this but we can learn this together’? That was crucial in establishing for the students what this STEM idea was all about.

Melanie: Do you think in the light of what you just said it would be better for teachers to be nominated, or whether they put their hand up and nominate themselves?

Eddie: That's a really good question! I don't know that we've discussed this as a group before. I’ll throw in my two cents and it's just my own personal experience. Certainly, I was nominated as the head teacher in the faculty. And when I thought about, *Well, okay I could do this ... but I have a lot of other things on my plate and I’d be happy to hand this to one of my other 20 staff*, but what I realised at least initially, was that it's really hard to delegate something that you don't know how to do yourself. And if I'm going to want, as did happen in subsequent years, other teachers to be able to have a go at this, give it a shot ... and for me to be able to mentor them in that I absolutely had to give it a go first.

In terms of whether they are nominated or whether they volunteer, that's tricky, because I wonder if rather a person self-selects or not, really, it’s about ... is this person able to work across the team, be enormously flexible? Because you're making up a lot, on the fly, all teachers do, but now you are suddenly doing that outside of your KLA and that’s a different kettle of fish. Those two pieces, regardless of whether someone sticks up their hand and volunteers or not, they are probably the crucial ingredients to someone who can participate effectively in a project like this.

George: I definitely agree with Eddie. Ideally, we would have people who are enthusiastic and understand the philosophy or even have in their mind a definition of what STEM education might bring to the students. But in a school setting, logistically speaking, it's not always possible and the reality is there are some situations where, in the case that we’ve had, we've had a lot of staff shifting even throughout the year, throughout the semester and even the terms, even week by week it would be different, and for a casual teacher or someone who’s just been told, essentially, you have to do it, to pick it up, it's very challenging. And really disrupts the initiative of the STEM outcomes that we are trying to achieve. But the reality is that's what happens. Ideally, we would have people nominated.

But I think Alesha mentioned at the very beginning of this project, because at our school, the TAS head teacher – we have to two TAS head teachers – the TAS head teacher is the nominated head teacher for this subject. Other schools have it differently, some might be a science head teacher or a maths head teacher and Alesha said that in order for STEM to succeed you really need a STEM head teacher. An actual STEM head teacher, whether it would be you are given period allocation or whether it’s the official title in an executive position because coordinating in our school three massive faculties that's almost 60 staff to try and get

something done in terms of finance and staffing and things like that and rooming becomes a big issue as well and so that was a huge challenge.

Melanie: So the design and the logistics of the project really matters, who is involved, how many staff, the timetabling, Eddie mentioned as well and some of those pieces of the puzzle should be planned out in advance so everybody knows what's going to happen and how it will work.

Could anyone tell me a little bit about whether there were industry connections in this project and, if so, what were those industry connections and what happened after the project finished in terms of that or whether there has been an ongoing interest in fostering more industry connections with the STEM learning and similar sorts of things in the school?

Yestum: The first one, we have appointed an ex-student who has gone to the Hadron Collider and he has brought in some very interesting experiences that he can share with the students. So that was really good. For the latest one that we have for the glider that we did the project I actually got James, working in one of our science labs. He's in the University of Western Sydney and he's involved in designing the things like water testing and designing something that will float so that they can actually grow some of the things in water. That can be used and he brought in his ideas to the students and he spoke to the students [about] what he did there and what were the important things they were looking for in a design. We are just very lucky that he happened to be working part-time in the science lab and I brought him in to explain to the kids, they were building the glider, they've got to cut things and he's got experience doing that so he was giving them very good advice ... these are things that is beyond, you know … if I go and research and do things I might not be able to explain things as well as him so I'm very lucky and fortunate to have him ... it's also a time factor, sometimes we don't have the time to make the connection with industry we would really like to if we can have the time. It's very difficult to do that sometimes.

Sometimes it's got to match with what we are doing too because we can't bring in people that were very keen to come, I got one from CSIRO. He's an engineer but it doesn't tie in with our project and it would be quite difficult to bring that in. He just wanted to come in and show something to the students but it's quite difficult and the time too it doesn't fit in with his timetable so sometimes there are a lot of other factors that have to be considered before we can even do those kinds of connections.

George: During the planning phase of the ACARA STEM Connections project we had every intention to find industry contacts. Because we were talking about the topsoil, the top playground soil … there is a local soil testing company and we had every intention to contact them but that never eventuated and it's quite challenging not only from a commercial point of view, the industry side. They're running a

business and of course in the big scheme of things it makes sense for industry to make connections with school because it's their future employees; however, it's quite challenging from a school point of view and the industry point of view to make those connections.

Eddie: One thing that is an overarching priority for all of the things related to STEM projects is you've got to know why you're doing any of these things and I know certainly at the beginning we remember looking at some of the original design of, 'This is what we'd like your school to do, this is how we want you to arrange it, this is what we want you to deliver to us as the documentation etc.' In the end it always came back to, well, what value do you get for the students and the change in their learning outcomes if you do it like this? What do you get from industry connections? What exactly are you hoping for this person coming into your school to give to your students that you couldn't get, for example, by getting them to research on the internet or by watching a video together? Is there some particular gain that can be had? And there certainly is from having someone who has direct contact with doing this as their daily work. And it was certainly important for us to think, *Okay, why are we getting this person in? Is it for the sake of having someone from a nearby business coming in or a connection or is there actually some things that can be learnt from them and also from the perspective of someone actually doing the job that we as teachers can actually say, yes, you need this scientific knowledge and this mathematical formula if you want to do this kind of job?* As opposed to, I'm doing this job; this is what I need every single day in terms of the knowledge that I developed at school and university and TAFE and all the rest.

So, again, the key about whether you have a lot of energy poured into your industry connections, because as George has just pointed out, it does take a lot of time and devotion to make that happen or you don't ... it's really about, well, why? Why are you doing that? And if you have a clear answer to that question it drives the decisions that you make.

Melanie: What are the connections, if any, that still exist between the people that were involved in the original project? You mentioned that you've certainly taken on board some of the science and mathematics learning and understanding from one another and ways of approaching the way you teach something. Are there any other things that may have carried on in terms of the way that you communicate or share or connections between those learning areas?

Eddie: My main connection to this in an ongoing way has been to really mentor the mathematics teachers who've gone on to continue teaching the STEM classes at Cherrybrook and it's been really wonderful for them, especially when they have less familiarity with the idea. They're getting to that point of, what's this supposed to look like? I really don't know, this is so different to the way I've taught things before – even just to give them that assurance, to say, yeah, that's okay, that's actually part of this, to put not just the kids but you as a teacher slightly out of your comfort zone.

That's a healthy thing and us teachers often like to have lots of structure, especially when we've been teaching for a while, and it's like, oh, this is something that's actually a place of comfort for us so to be able to help nudge people along that direction has been very helpful and also to bring that mentality of, look, in Mathematics, the classic problem is students need to learn things in a fairly specific sequence and arranged in a particular way and that's the way we think about it within our KLA but I'll never forget the first time we were sitting down and doing some planning about when are we going to learn this, when we going learn that, when will this science bit and this maths bit and this engineering bit fit together, and I remember thinking about graphing, which was something which we wanted our students to be able to bring in to their report form … If we increase this number of bits of astroturf or grass or play equipment or paths, what effect will that have? We wanted them to build a graph on that and I was very insistent originally. Well, we need to have, this needs to fit with the way everything is sequenced already, what the scope and sequence looks like in Mathematics, and then I realised, actually, graphing has been learnt in all these other KLAs before it happens in maths. Why am I being so hung up on the way it's being ordered in my subject when in other KLAs that our same students that we are all teaching have engaged with [it]. So it certainly has given me the opportunity to help mentor these maths teachers who have to really reconfigure their brains to teach everything in a different way, particularly through their involvement with STEM projects now.

George: One thing that has carried over from the ACARA STEM project was just the logistics of things, in terms of talking with the timetabler, talking about the room allocations, because over the four years now we've really refined the way that we select classrooms in terms of – initially we put 50 students in one classroom and the room's not designed for 50 students – we now have rooms designed for large spaces like that but through that we've now, through the timetabling that … the timetabling person has to be on board, the deputy principal, the principal has to all be on board, the faculty head teachers need to all be on board to have their staff teach at this particular time because the way it operates now is we still have two classes running parallel but they run just above and below each other, and so in the case that the maths teacher or the science teacher or the TAS teacher need to swap classes it just makes it easy because of the way that we've been able to have that conversation at the very early stages of our planning and that has continued throughout and it will be a continual refining process of the logistics side of things, and so that's been a really great learning process for the whole school.

Eddie: George has pointed out really, really helpfully that logistics can't be underestimated. In the very first year when we ran this because we had sort of come up with the idea, it was quite towards the end of the year, the timetable was already in place and so, for example, when I wanted to come in to co-teach a particular lesson someone would have to come and relieve my Year 12 class and we would swap places and it was a bit of a nightmare, honestly. The concept was great but

because we didn't have the structure set up to facilitate that, it made it very difficult. We sort of survived on the good will of each other, taking each other's classes and all the rest but you often, you certainly don't want to rely on that in the long-term fashion and so that's why it is so critical to have a whole-school approach and strategy to implementing something like this.

Melanie: Do each of you feel that you have the skills and knowledge to plan and develop STEM units in the future?

Eddie: I think any of us are far more confident than what we were before we started this journey but if there's one thing I've learnt it's that particularly in a high school, disciplines stay in their compartments far too often, even when there's huge amounts of overlap in what we teach.

I was used to teaching entire units on data and statistics and probability, and what did I do, I made up data sets to be able to investigate when I had these experiments happening all around me every day. A student would go from a lesson where they had just done an experiment, just collected some great genuine data that they're ready to analyse and then I'd hand them a completely fictitious set of data and I'd say, 'Okay, well let's have a look at this'. So what I'm trying to say is that any STEM, any genuine STEM project, has to be designed collaboratively but it's certainly helpful to have had that prior experience. I could certainly take a team that's less experienced in that now having gone through with this team and having learnt so much from them to say, 'Okay, here's the way we go about designing this, here are the ways in which we need to be aware of timetable structures and staffing and all the rest, but I can help up-skill you in thinking in this different way about your KLA and also about the pedagogy of teaching these different concepts. But it's okay to have it as a team effort. Unless you do that you're always going to have that bias in it and we were very conscious of the fact that sometimes a STEM project can be maths plus a little bit of lip service paid to something else or any of the others so it's really important that it's genuinely STEM and it involves everyone at the table.

George: Through this ACARA STEM Connections project we've definitely started the conversation and without that I don't think the STEM program at our school would be in its stage right now. It's becoming adolescent stage maybe, the STEM project at our school. There's still some teenage years for it to mature but definitely I'd feel very confident at being able to prepare a STEM program through the skills that I've been able to develop through this project.

Melanie: What does STEM look like now in the school and what will it look like going forward?

George: Right now STEM, we run it as a Stage 5 for Year 9 and Year 10 and it's run as four semester courses, and so a student might elect to major in STEM and that would be 200 hours' worth and each course is 50 hours. So some might just choose STEM 1 but they can go all the way through to STEM 4, and the Year 9 project we

are currently doing on drones and Yestum is teaching Year 10 and you're doing the glider project.

Yetsum: Glider, that was the first one. We have glider and then after that we have problem-solving, so we gave the students a problem to solve and they come up with their own design experiments. It's a bit different from the first one that we have on the glider because the whole class were just doing the same kind of thing and they limit the scope in terms of different kind of investigation. The advantage is, from the teacher's point of view, we can structure in a way to bring in other skills that we want for the kids to learn like maths or science and design. But the second one is a bit more open. So there is a lot of challenges because we have to find out what the kids are learning, the students, and what are they interested in so they come up with a problem then we will help them, direct them, to get research and more often they just go to the science lab and speak to the lab technician and say we want to do an experiment on this, this, this. Do we have all these in the science lab or do we have to go and logistically go and purchase that from somewhere else?

So, a lot of running around for the teachers and a lot more challenging for the teachers in terms of the ideas they generate and the diverse problems that the students are looking at. But the other thing is to engage the students, so for the group of students that are really keen, they will just be very keen in the area that they're interested in. But the other group of students we have our challenging time with them because we need to monitor them, find out what they're doing, giving them more help, more direction, so it's quite different from the first one that we're doing but it's also a learning experience for me. I haven't stop learning. I believe the next year we will still be learning. I wouldn't say we are at a very mature stage yet in terms of implementing our STEM program. It's always changing just like we don't know what the future job is or what the future skills would be needed for the students to be employed; jobs that are not existing now and will be existing in the future so because of that teachers must be ready to be able to sometimes experience failure so we become more perseverant and teach the children to be more perseverant in whatever they want to learn because these are all different steps of learning and I believe as a teacher it's very challenging for us. We will have to be very open to all these ideas that come along and be able to change and be able to modify whatever our thinking program is, learning program is, so that we can keep it for our students to prepare.

George: Just to clarify, we're teaching the Stage 5 i-STEM school-developed Board-endorsed course. That's the one we're teaching and so there are all these aspects that we have to meet so in the future I see us continuing with this i-STEM course because that's the one we've been approved to teach. However, the good thing about this is we can wrap it in any context that we want. All the fundamentals are the same and so this year we've decided with the glider for Year 10, and Year 9 it's the drone project so in the future I would imagine as staff evolve and staff change and become more confident in various areas that the course will still continue but just

different contexts might be applied to them. And moving forward, as a final comment, as the draft curriculum review has already come out and as we have read some parts of it, I think the nature of STEM, the philosophy or the idea of STEM education is kind of embodied in what we want the curriculum to look like in the future as inevitably we teach, as Eddie mentioned, in these compartments, and it's quite frustrating when you're trying to teach Science out of context or you're teaching I would imagine Maths, as well, it would be very challenging to teach Maths just in isolation and students don't see those links and unfortunately I hear from some staff that they don't even know the links and they're trying to teach Maths or teach Science in the broader context. It's great that our school had the opportunity to be able to participate in that because as we move forward 10 years or however long it's going to take to implement what the curriculum review has said that it's going to do, it's set a great precedent for what we're going to do in the future and really put us a step ahead in terms of being able to implement these individual projects that they were talking about.

Melanie: That's wonderful. Yestum Yang, Eddie Woo, George An. Thank you very much for your time and all your wonderful insights about the STEM learning here at Cherrybrook High. Thank you.