GC: Hello, welcome to Episode 26 of Learning and Teaching at Newcastle University. My name is Glen Campey and I'll be your host for this episode.

The beginning of June usually sees two large gaming events taking place, in the UK Games Expo and E3, which is the huge video games industry event, and to embrace and celebrate this, we have a gamification special.

Later on, we'll hear from Pascal Steifenhoffer about creating and using pedagogical games of mathematical proof. But first, I spoke to Sarah Carnegie and Tracy Scurry about a board game that they were part of developing.

SC: Hello, I'm Sarah Carnegie, a lecturer at the business school.

TS: I'm Tracy Scurry, also an academic at the business school at Newcastle University.

GC: Great, thanks. Could you… for the people that couldn't be at your session at the Learning and Teaching Conference, could you briefly describe what you did when you were developing this game with students?

SC: The game was actually a project that we set students on a capstone module where we find external clients to work with students on a business issue or a business project. This was slightly different in that they actually worked with Tracy as the client, because she was at that time on secondment at faculty level, where we set them the challenge of developing a game that would improve cross-cultural awareness and team working, because we were aware of this was something that could be improved and this seemed to be a particularly positive way to address it. And the initiative, I suppose, came from… I'd actually been to a conference. Walking around, I was really surprised at the number of people selling board games for management education, and it just struck me that this would be a really interesting project for them to work on.

I have to say that the students themselves were not that enamoured at the start of the project. They couldn't really see how this was a business issue, but they soon became very enthused by it and were thoroughly engrossed in actually the development of the game.

TS: As the client, our perspective was less about the focus of this from a business and management context of the module, but it was more about the, sort of, opportunity that games present for students to build community, engage with cross-cultural awareness and interaction. And then also that opportunity to start thinking about the Sustainable Development Goals as a bit of a framework for doing this and raising awareness and literacy around sustainable development goals, although not the focus of the game, was quite a good framework for… I was going to say a framework for framing the ideas around the cross-cultural awareness and interactions that we were hoping the game would generate.

The work of the students was key on this because it's… Them. They are the audience; they are the client, they are the kind of the game. So actually, that was the really important bit of this. I think if Sarah and I had tried to come up with something, it wouldn't have engaged the demographic as much. They really got to grips with the purpose of the game, both in terms of as a learning tool within the university, but also as something that organisations could take on as part of wider developments. Like Sarah was saying, there's been an increase in board games as part of professional development within organisations.

SC: It was quite interesting helping them work through what the game was there to do. They had to do quite a lot of initial research about, you know, what is cross-cultural communication, what we need to do in the stanching good team, working habits, etc. And then they went away and studied gamification of teaching and learning, which told them a lot about the underpinning pedagogical sort of thinking. But I think their big breakthrough was actually going and finding some similar games and then unpicking what they did and how they did it to come up with a game that actually delivered the outcomes that we'd asked them to focus on. So there was quite a lot of, I suppose you could call it, kind of testing of concepts, and is this going to work actually as a game? There were very clear that it needed to actually work as a game. If people are going to engage with it, it has to be reasonable fun to play. So they did quite a lot of testing.

TS: The other thing that was key with that is that they interviewed also… experts who either deliver gaming for organisations or have used gaming in their organisation.

And they also spoke to academics who were using or thinking about this from a learning and teaching perspective. So again, that insight that they'll take into the workplace, as well as thinking about it from an educational perspective as well, and really thinking through what are students learning? How complex do we need the game to be? What's the pace of the game? What kind of session would this be delivered in? There's no point it being sort of a Monopoly length game, because it's likely to only get 20 minutes to 30 minutes to deliver. What's the scoring? Do we want this to be competitive? How do we make that competitive in a way that fills the aims of what we're trying to do rather than value one person's knowledge over another? So they really go into all of this and then, sort of… "how do we make this not naff?". Because that was what they were really worried about. A lot of games were a little bit, you know, naff, aren't they? But then as they got into this and realised that actually, they're not, they really sort of came around. So they really thought about this in a much more sophisticated way, than I'd initially expected them to.

SC: It went off in directions that we weren't anticipating, and I think it's a much richer outcome for having the students actually create it within that that kind of structure of the module. What we've done with it from there is that we've taken their hand painted on bits of cereal box cardboard, kind of… prototype…

TS: Beautifully hand-painted!

SC: Yes! But we've taken off… they had all sorts of interesting… cultural images on it, and we thought, well, you know… that's picking one above another. So we've come up with a fairly neutral design – well… our marketing team did - and they've created a quite smart actual real life board game. We're now just wanting to see what impact it has in terms of the outcomes that we set for it. It's working as a game. People are enjoying playing it. It would be nice to know how much it actually impacts on awareness of the Sustainable Development Goals, improving people's understanding of different cultures, and improving that team working aspect, which was quite important. Because one of the aspects of the game is to stimulate a round table discussion about cultural activity, not just "I know stuff", which is, you know… "I know the answer to that sustainable development goal question," or "I know the

answer to…" you know… "what's the national dish of Indonesia?" But to actually have some discussion questions to get that, kind of… really breaking down barriers, getting people to talk to each other. So, the game is working great. We now just need to know whether it's actually having the outcomes we wanted for it.

GC: How did that, sort of… get underway? So, the group of students who took it on as a project, what did their assignment brief look like? And what were the learning outcomes?

SC: It was… "we think there is scope to design a game that will improve cross-cultural communication and team working for students. Off you go!" Because part of the learning on the module is understanding how to work with a client to refine what they want. So it's part of the learning requirements, or the learning outcomes of the actual module they were on to take a very - at times - quite spurious, and sometimes quite ill-conceived concept that the client has, and then actually work up… "What are we actually going to do?" and "how we can structure this so that there's a clear plan put together?" for them to act as consultants on creating or doing some work for a client. So it's intentional to be vague at the start.

GC: I think you said they were reluctant at first, maybe, but got on board later on?

SC: Yes. Yes.

TS: So I had to put quite a lot of effort into the first meeting, showing them that the university is a business. Because some other projects were with external third sector, not-for-profits, and different kinds of organisations as well. But because it was the university they sort of felt that it wasn't a real organisation and that it wasn't as credible or as good on their CV as if they worked for a client out. So there was a bit of a perception that this wasn't a proper business and management project.

So I spent a good hour or so giving a bit of context about the institution, what it does, how it's structured, where this fit into the strategic aims of the faculty. It was commissioned from the HaSS Faculty Education team - which I was part of as Associate Dean at the time - and the role of student experience as part of the university as a business. So it gave them a bit more context, and they really engaged with it actually, in their final report when they all clicked that… "Oh, it is a business".

But again, that's quite a big, steep learning curve because it's not necessarily something you think about if it's somewhere you go for your education.

SC: Subsequently, since we had the game developed, well, the prototype version - all designed and printed up and everything - I had a connection with one of the team on LinkedIn and posted it there, and then all of them have piled in with sort of… "This is great… marvellous!" and were obviously thoroughly proud of themselves. Now, it's actually… they can see it's a tangible outcome and they were responsible. They are cited and thanked for doing the actual original work in the rule sheet. So, yeah, very much a student project.

TS: I think we should probably give them a shout out really, shouldn't we? And I know you'll include their names, Glen, but we had Jonty, Benjamin, Harit, Jessica, Alice, Andrew and Matt. So just to give them a shout out, because they did all the hard work, really.

GC: What is the game called, as well?

SC: Get Sust! So get, G.E.T. and then S.U.S.T. exclamation mark.

GC: That was in the title of your session at the Conference. Do you think you'd recommend this sort of approach to colleagues elsewhere in the university for teaching things?

SC: I think there's a huge difference between doing a consultancy project, which would be asking students to undertake some research for a… a change or a business issue that you're wanting to address, and then saying we'd actually like you to design something to be used teaching: they're two very different things. They just happened to coincide to this particular project. I think my key bit of advice is to really think about why you're doing it. With the project the students did - the module they did - is very much an experiential learning project where it's putting their taught knowledge into practice by working through a business problem. So that's got validity. Just going and saying… "Right, we've got this module, put gamification in as the assessment." I don't think would work.

TS: I think that this is the next bit we're looking at now, Glen. We think there's value in that game and then the game actually being used by students. There was value in

that process of the development of the game and working with the students both in terms of the students in their module and their learning, but also for us for getting that input into something that we thought might be valuable. It turned out to be a much more valuable thing than we even initially thought it would be in terms of what it brings for the people engaging with it.

Our next challenge now is: how do we embed and integrate this into student experience within the business school or elsewhere? And where does that happen? How do we know that it's happening well? And then the other thing that we've discussed - and we're nowhere near having an answer for - is how is this part of something more? Particularly around that Sustainable Development Goal awareness, team building, community building… because as a one-off single event, it's not going to deliver on that. So how do we think about that as being part of an ongoing process around these things?

An important part, because the feedback we've had to date is… it's really… the game model really helps to stimulate this, and some of the feedback from students - because we did it in second semester because of various public health concerns - was "why couldn't I have this in my first semester? This would have been amazing!" So obviously it's doing something. It seems to be that this approach will be really valuable for the goals that the game is looking to achieve. But we need to keep thinking about that longer term.

SC: Yes, and scaffolding it in some way, so it's not just this sort of one lonely little signpost, but there's actually something built up around it. But yeah, as a starting point, at least it's got people talking.

TS: I think there's something as well… from a school perspective, but also am institutional perspective, is if we are raising awareness and literacy around the SDGs as students do this and say "I want to know more, I'm really interested…" Where do they go? How do they do that? And I think that's another bit that we're actually discussing on the UNSDG subcommittee around how we provide that space for students to know how they can learn more, how they can get engaged with what's going on at the institution. Are there opportunities to pick this up in their programme, and their learning, or extra-curricular activities? So that's the other bit

that we need to discuss. If we get that interest and pique that curiosity and raise awareness and then it falls, kind of… flat and – as Sarah says - isn't scaffolded, then then that's problematic because it's not then providing that opportunity to progress and raise awareness further.

GC: A very big thank you to Sarah and Tracy for their time and for sharing their experience. Next, we hear from Pascal Steifenhoffer, also from the business school, who has been conducting research into a different approach to teaching advanced mathematics.

PS: My name is Pascal Steifenhoffer, I'm based at the business school. I'm currently in the role of Director of Studies for the undergraduate programs at the business school. By training, I'm an economist and mathematician and depending on my audience, I change hats. Sometimes the mathematician comes to and sometimes the economist comes to.

GC: Why is it you decided on this approach of using games to try to teach these concepts?

PS: Part of what I discussed at this conference is actually developing the games themselves as well. So the conference focussed more on the quality assurance model of how to compare games. But of course a key element of my research is to develop pedagogical games of mathematical proof - how I called them before. Just briefly, like what I do in terms of these games, what they are is… I use toys in teaching mathematics. This is an idea which came to me when I played with my 2 year old son when he was a toddler. He had this wooden box with holes in it, and then he had these wooden, geometric objects that we were trying to fit into the holes and to get these wooden objects inside the box. And there naturally some interesting mathematical questions that you can address here. For example, some questions might be related to combinatorics and how many different ways. Can you try to fit a shape… a geometric wooden object into a particular hole? But I don't think that he was keen in studying combinatorics around that time!

So, I think for my son it was more taking three dimensional objects and trying to see how they can fit within two dimensional holes in these boxes. So, it was more like a

geometric interpretation of shapes, and of course, to try to fit this object into the box and have some successful feeling whenever he achieved it.

So, the idea then for my students is to take this wooden shape sorter and ask the students… or help students to derive mathematical proofs, because this is a big problem when teaching social science students for two main reasons. One reason is social science students don't necessarily have great preference for doing mathematics, and then another problem is that, in my lectures, I realised that students expressed some low level of engagement with the subject, so this motivated me to do some playful activity in learning. A key problem… So, I noticed that students are not fully engaging with my module, and the module that I was teaching was advanced mathematics to social science students. This is a very demanding module in terms of the level, and in terms of quantity that we have to cover in a relatively short time.

Observing the low level of engagement of a large proportion of students motivated me to do some surveys to investigate why students are not fully engaging with the subject. This revealed that there is some level of anxiety in this module, so I wanted to investigate this a little bit further, and we did some anxiety… specific measures of anxiety with our students and it showed that up to 30%; nearly 30% percent of the students expressed some level of mathematics anxiety, which is a very particular type of anxiety.

So, the activities then - if students have a shown or expressed some sort of mathematics anxiety - is to reduce the level of mathematics in these learning activities; to take away all the unnecessary mathematical complexity in deriving mathematical proofs.

So, the idea was to take this toy, exactly the same toy, actually! I use the same toy for my students, and I introduce students to this toy and wrote down a list of activities that they need to do. And it's actually very, very simple: take an equilateral triangle, and then have this wooden shape sorter with the hole of the same shape in it, and then ask students to follow a set of instructions. So the set of instructions will naturally guide students to proving some very advanced concepts in mathematics like group properties, abelian group properties, sub-group properties…you know,

advanced abstract algebra concepts that students are just anxious to hear and to speak about those concepts already. Because once you look at a definition in written form, it looks terrible! All these symbols… and it can be very confusing for some students. This may create some sort of anxiety. So I use this wooden shape sorter to replace the mathematical calculations. Instead of writing down a matrix showing how you rotate an object 120 degrees, it's really… it's a lot of work to do this and it's not… it's a lot of calculations. But this actually distracts students from understanding the key idea in the process of the proof, which is just rotated by 120 degrees. That's very simple to understand in words, and it's very simple to do it with hands, you know: rotate 120 degrees; rotate this equilateral triangle by one third and see whether it fits again into the hole. If yes: write it down in a table. And rotate it the other direction, or you can rotate the other… write down this process in a table. So, they could - instead of actually doing complex calculations using matrix algebra of trigonometric functions - they could use their hands to replace, the mathematical calculation.

So, the key idea of using toys in my learning is really to deconstruct a mathematical proof, and if you reduce it down to the key ideas of the proof, and help students in using toys, their hands, their physical presence as a replacement of the calculations to derive conclusions about propositions.

GC: So how have students responded to that, and particularly ones who may have had particular anxieties around mathematics?

PS: One of the surprising outcomes was that students started to developed some sort of identity… group identities. I need to elaborate a little bit. So the learning activities that we designed as part of this research project, this was based on the constructivist paradigm which embeds active learning as part of it and as a pedagogy - because I like to call these pedagogical games of mathematical proofs – they had to be embedded within some meaningful pedagogy, which addresses reducing mathematics anxiety, in this particular case. So, one element of the pedagogy of these games was cooperative learning. So students sit down in groups. They had one toy available to them, and there was an element of chance to who is the next one to explore the next operation on the object and to write down it on the table. And this

causes students to communicate with each other, to laugh: laughter is always great in seminars, it relaxes students. It becomes a very lively session, and students were really nicely working in teams. To come back on the identity thing that I discovered and was surprised about, the outcome was that students realise they're all in the same boat: it's difficult for everyone! And I thought that was a really good starting point to build up student learning, because after these activities they start to organise themselves in in small groups and small study groups and they realise it can actually be quite fun to learn together.

Then there are also some specific output… outcomes that we measure. There are two types of studies that that we did with the cohort of students. One is a product usability study, and this is more about quality assurance: how can we use this quality assurance model to measure the effectiveness of learning and pedagogies and things like this. The other thing - which is more related to what we are talking about today, about pedagogical games and gamification in learning and teaching - is did a survey of attitudes towards learning mathematics. We could see, despite only having two one hour sessions spent over two weeks - a one hour session per week - doing this kind of exercise with the students already showed some evidence of improving student attitudes. They seemed to find these kinds of activities fun on average, and one specific element of this attitude survey – it's based on six dimensions - and one of the dimensions is really measuring mathematics anxiety; feelings towards mathematics.

We could see a clear improvement there for students. They seemed to have appreciated this idea of, on one hand, working together; on the other hand, stripping down the complexity of a mathematical problem to the essentials and not to be too much engaged with unnecessary vocabulary and calculations. And these are very, very desirable results.

There is evidence that high achieving students tend not to enjoy these activities so much, and do not benefit from these activities in terms of performance: one of the reasons is that potentially they already have successful learning strategies, so they may not need these kinds of activities. But for those students who demand these kind of activities, we would clearly see an improvement. So that's why in designing a

game, there is not a formula which fits all. It's when we designed these pedagogical games that they would need to address a particular demand of a need; clearly identified needs, which we had in our case.

GC: Using during games like this, to teach concepts: is that something you'd recommend to other colleagues? And if so, how? What do you think the starting point would be?

PS: Well, the short answer is absolutely, yes!

In general, my recommendation to educators is take more risks in your teaching. Try out things, because our learning environment is rapidly shifting. We just had this pandemic; we changed our teaching. We have a digital revolution, which changes our teaching as well. There is so much more technology at our disposal to try, and to use in our teaching.

The message here, again, is: if you want to use gamification now, in particular in your teaching, then there are two aspects. One is; identify the need and try to address something in particular with your game and explain this to students before you play games. Otherwise, it reduces to having fun without any clear goals that students would recognise, that they would achieve it. So it's very clear to communicate your activity in advance and what you are trying to achieve with this, and also, to have a need for this target.

Of course, the other one: it should not only be a pure fun activity, it should be embedded within a pedagogy. That's why we want to call these games pedagogical games of mathematical proof, and not just gamification, because it could be a little bit ambiguous what we mean by gamification. The literature on digitalised games sometimes is not really clear whether the game is first developed and then used as a learning tool, or if the game is designed as being a learning tool. So, sometimes they are void of a specific pedagogy in the way these games are designed. This is something that I would really encourage to think about: the pedagogy that that you embed within the game, that that you are designing so that you can address the specific needs within the context that we know is likely to be to be more successful.

So what I did in my own research is - in my own experience - is once I knew there is a need for change, there is a demand for some new learning activities to help students with anxious feelings in mathematics lectures, I put together a team of researchers.

I asked two other colleagues to join me - whether they would be interested in investigating mathematics anxiety in more detail - and how we could develop some learning material to support anxious students. We put together a team of three core researchers and six undergraduate students to work in the role of co-researcher with us. So just to have a more of education project where students can co-create with us their own learning activities. It has been really enjoyable seeing undergraduate students in the role of part-time remunerated co-researcher to work on co-creating their own learning material with us.

So this is… there are two trends in this already. One trend is the trend where we see universities going towards more undergraduate research, embedding more inquiry based learning in the early stages of their curriculum, that's one trend. Secondly, the other trend is to co-create learning material with students. New trends where we are co-creating assessment with students, co-creating curricula with students and so on... So, we wanted to be early explorers of these trends as well by building this group of students, and the students have enjoyed this very much. One student gave us feedback that he could talk about this learning experience at a job interview. This is this is already a success in itself. And for us as well to understand the needs of students, much better to collaborate with students on co-creating learning material has been in itself a very interesting learning experience for us.

GC: Thanks once again to Pascal and to our other contributors this time, Tracy Scurry and Sarah Carnegie. That's all for this episode, but join us again in two weeks' time for the next episode of Learning and Teaching at Newcastle University.