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Multi-Digit Subtraction: Alternative Assessment 501

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Education Notes bring mathematical and educational ideas forth to the CMS readership in a manner that promotes discussion of relevant topics including research, activities, issues, and noteworthy news items. Comments, suggestions, and submissions are welcome.

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I've been flying a lot, which means I've been talking to strangers. Just old people, however. Young people (who, I think, should be in school or at work, especially on a weekday) already have their headphones on/in and are streaming/scrolling on their phone/tablet before I can even turn my head to acknowledge their existence (and that of their Labubu). Old people, they make eye contact, acknowledge the existence of another human being and even, yes, sometimes strike up a conversation.

On a recent flight, a conversation continued beyond flight and airplane and destination pleasantries. Eventually getting to the inevitable "What do you do?" question, I told my seatmate that I taught future math teachers. Unlike in past experiences, where my declaration would result in moving on to another topic of conversation, they were interested and, to my surprise, had a bunch of questions.

Both of us on our way to Toronto, we talked about the *Mathematics Proficiency Test* (MPT) that was recently reinstated as a requirement for teachers who are looking to be certified in Ontario, which they were familiar with because, well, they were old, lived in Ontario and followed the news. They were gobsmacked when I told them that some students were still coming to grips with their times tables during the first year of university these days. I even told them about my *Elementary Mathematics Teacher Adeptness Test* (the ELEMTAT), which is where I have students in my Methods for Elementary Mathematics class (ECUR 312) write a grade seven/eight final exam, in mathematics, yes, as their final exam for my course. As an idea, they quite liked the ELEMTAT, and even asked if my exam, like the MPT, was ever challenged in court, which resulted in a good chuckle. We talked about a lot of things other than mathematical content knowledge. We just kept talking.

At some point over Manitoba, and I'm still not really sure how we got there (in terms of the conversation, that is), we started talking about alternative forms of assessment. When they went to school, they never experienced project-based learning or portfolios or journalling in math class. Me, too, I told them, but then I reminded them we were old, which got us both to have another good chuckle. Then, while talking about math-class staples (quizzes, tests and exams) our conversation shifted to grading, marking and evaluating alternative forms of assessment in, of all classes, math class. I'll be honest, I didn't have great answers to all of their questions, but I did have one pretty decent answer (in my opinion) to their very well posed general question, which I paraphrase here as, *Well, I guess what I'm asking is… What sort of alternative assessment would let you really know that they know what they're supposed to know?* A great question. What follows is a recreation of my answer.

As I mentioned at the outset, and as I told my seatmate, I've been flying a lot. On a recent trip to Europe, I proceeded to tell them, my wife and I were "stuck" in our hotel room one evening and, as ugly North Americans are apt to do, we turned on the television. Ok, ok, I turned on the television. Flipping through the channels (yes, looking for an "English" channel, no, I don't speak Dutch), I stumbled on an airing of Premier League action. No, not Premier League Football (read: Soccer). Premier League Darts!

That's right, Premier League Darts is a thing. Actually, if the audience in the arena, that's right, the arena (e.g., The 02, London or AO Arena, Manchester), is any indication, it's a big thing. In front of a crowd of 14000 people, wearing costumes, drinking beer and incessantly chanting and singing, two contestants throw darts at a tiny, little dart board, which is set up on a stage strategically placed somewhere in the vast arena. Thankfully, due to some excellent camera work, everything that is happening on the stage gets projected in real time onto super large televisions for the many, many thousands that are way too far away to see whether that last dart thrown was a double or triple twenty (or treble twenty). The whole scene is akin to a concert. As my wife nodded off to sleep, me, I became more and more glued to the television.

Learning as I watched, Premier League Darts adheres to, what (I later learned) is called, 501 Darts. In this version of the game, both contestants start with 501 points, and the goal is to get to exactly zero. Taking turns, they each get to throw three darts (per round) at a dartboard which is numbered, clockwise from the top, as 20, 1, 18, 4, 13, 6, 10, 15, 2, 17, 3, 19, 7, 16, 8, 11, 14, 9, 12, 5. Should your three darts land, say, 20, 1 and 5 then you would take 26 points off your starting total of 501 and then the next turn you would start at 475. Add to the mix that there is an inner bullseye, which is worth 50; an outer bullseye (a ring around the inner bullseye) worth 25; a very thin, inner concentric circle called the Treble (or Triple) Ring, which results in three times as many points for the dart (e.g., landing in the treble ring relative to the 20 "slice" or "wedge" makes 60); and, another very thin, outer concentric circle called the Double Ring, which doubles your points. In addition, you must land in the double ring with the dart that gets you exactly to zero or you "bust" and have to start your next turn where you started your last turn. Lots going on.

Looking at an example, albeit for just one player, 501 less 180 (Treble 20 x 3 darts) then less 180 (Treble 20 x 3 darts) again leaves one with 141. With 141 remaining, landing 60 (Treble 20), 57 (Treble 19) and 24 (Double 12) would get you to zero. As long as you got to zero before your opponent, you win that "leg" of the match. Then, depending on the gravity of the match you are playing, the match becomes a race and the first to reach a particular number of legs wins.

My apologies to those of you reading that are intimately familiar with the game and, say, the notion of preferred checkouts. For those of you not familiar with the game, there's a vast

number of resources on the Internet, as expected, should this dartboard discussion have piqued your interest. It's time, however, for me to get back to my recreation of my answer to the very nice, old person on the plane that asked me, when it comes to alternative forms of assessment, which was something along the lines of, *What sort of alternative assessment in math class would let me really know that they really know what they're supposed to know?*

The set up for my answer went better than I thought. First off, my seatmate was familiar with darts. They had played the game in their youth in a friend's basement and even had played it in a pub a few times during what they called their formative years. Second, they were unfamiliar with Specific Expectation B2.4 and B2.5 (Addition and Subtraction) of B2 (Operations) of B (Number) of the Expectations by Strand of the Grade 3 Mathematics Curriculum of the province of Ontario; however, when I rephrased things as being able to subtract one, two or three digit numbers from a three digit number, for example, 501 – 139 or 362 – 29, they knew immediately what I was talking about. Lastly, in terms of my setup, when I asked them if they had ever watched Premier League Darts on television, they replied that the only Premier League they had ever watched was Soccer.

Just like my wife, my seatmate was surprised to learn that I had watched Premier League Darts late into the night while in a hotel room in Amsterdam. I couldn't stop watching. It was amazing from every angle. The crowd, for example. I still can't get over the crowd. Close to 15000 people all gathered in one place to watch people playing darts is impressive. The darters, too, were impressive. The hand eye coordination, the skill level, the practice and commitment, all of it, very impressive. The most important , however, sure, from the perspective of someone who has dedicated their working life to the teaching and learning of mathematics, the underlying mental arithmetic prowess of the darters.

Seamlessly, effortlessly, whether making a shot, but especially when missing an intended shot, the mental arithmetic of the darters is strong, but it wasn't really discussed during the television broadcast. It just was. Sure, throwing three darts into the teeny tiny Treble 20 part of the dart board is very impressive. It is. Just as impressive, in my opinion, is changing outs (your checkout) when, say, your first dart misses. Only needing, say, 67 to checkout, the plan is simple, triple 17 (51) and double 8 (16). Two darts. Easy. Unless, that is, you miss the triple 17 and then land on a single 17, which leave you 50, which means you could land double bullseye to get to zero. What if you miss the bullseye, however. Ok, let's look at three darts. Triple 9 (27) and double 20 (40) would work and if you missed the triple 9 then you could use your single 9 (9) then single (18) and then double 20 (40) to get to zero. All of that mental arithmetic happening ahead of time and in real time as the darter walks up to the line and throws their three darts. That's why I was watching darts late into the night. Further, it's not just the darter that was exuded an undercurrent of mental arithmetic prowess during the airing of Premier League Darts I watched that night in the hotel.

In addition to the two darters, on that little stage in front of a sea of tens of thousands of people, there is a Referee (also know as the Caller). The job of the referee, with only a microphone in their hand, is to announce the total of the darts thrown. Treble 20 for all three darts in a turn would result in a resounding, protracted announcement of 180 to the crowd. To which the crowd would raucously cheer and applaud in response. Similarly, however, they would have to announce 61 for when the darter lands 19, while trying for treble 19, and then decides and lands treble 14 because they're looking to reach a particular number for their next turn. No delays, no asking to be given a second while they make sure their calculation is correct. Just a simple, calm announcement of 61 into the microphone. The mental arithmetic skills of the referee in Premier League Darts is impressive. The same goes for that fourth person on the stage.

The first time that I saw the Marker (also known as the Chalker) I was uneasy. I was uneasy because of how close they stood next to the dart board. From the perspective of someone who did not enjoy getting called up to the chalkboard in math class, the sheer notion of the Marker is the stuff of nightmares. The job of the marker, you guessed it, is to keep track of the points. The marker is in charge of subtracting – in front of tens of thousands of people and however many people are watching on their televisions or phones or whatever – the totals announced by the referee on a whiteboard. Both players. No pausing. No asking for a second or two to make sure they borrowed from the hundreds column properly and got that one correct. Just subtraction from 501 over and over and over. Subtraction of one, two and three digit numbers from one, two and three digit numbers (you know what I mean). I would also point out, beyond the massive audience watching your incessant subtraction, there are major stakes for the darters, that is, there is no room for mistakes because they're working just as fast and have the total, too. Like I said, a nightmare for anyone that was ever called up to the front of the room in math class and, subsequently, had a bad experience. I should point out that I do believe that the darters, the referee and the marker are not working in silos, that is, I believe that all four people on the stage are working out all of the mental arithmetic all of the time. My belief stems from the mental arithmetic skills that were also displayed by commentators and analysts associated with the television broadcast.

I don't know who the commentators were for the broadcast that I watched. Perhaps they are professional commentators, perhaps they were former professional darters. No matter. The mental arithmetic skills of the commentators was also impressive. They were doing the arithmetic, all of it, and doing it a half step before the Referee and the Caller. Their skills were especially on display the closer each of the darters got to zero. Using my earlier example of needing 67 to checkout, the commentators, without hesitation, seeing a missed treble 17 would result in a comment about whether the darter was "shy" about the bullseye (double 25) at this point relative to what the other darter has left, and whether they were going to rely on three darts instead of two. Mental-arithmetic-based colour commentary. Wow! Whether the darters, the referee, the caller or the commentators, the undercurrent of mental arithmetic is a thing of beauty in Premier League Darts. It was at this point that my seatmate politely interrupted my long winded set up.

They, my seatmate, wasn't trying to be rude. Rather, we were about to land and they wanted to make sure that I wasn't skirting the question they had asked about alternative forms of assessment in the mathematics classroom, and how I could know, for sure, that a math student knew what they were supposed to know. Turning to them, making eye contact, shaking their hand and thanking them for a lovely conversation, I told them that if they wanted to be sure that a student in grade 3 had met Specific Expectation B2.4 and B2.5 (Addition and Subtraction) of B2 (Operations) of B (Number) of the Expectations by Strand of the Grade 3 Mathematics Curriculum of the province of Ontario then I would, yes, rely on an alternative form assessment. I call it Alternative Assessment 501 for multi-digit subtraction: could I replace, either of the darters, the referee, the chalker or the announcers with that grade three math student, and that the broadcast, from a mental arithmetic perspective, not skip a beat. If so, then I knew that they knew what the needed to know. With my response, gathering their things, they paused for a minute.

After the pause, they rightfully noted that it would be a little harsh to put a grade 3 student in such a predicament. I acquiesced. I did note, however, that we were discussing alternative forms of assessment, which meant that a teacher could, in their classroom, do their very best to recreate a broadcast of the Premier League Darts that I watched on television that one night in a hotel in Amsterdam. Different students in different roles, that is, two darters, a referee, a chalker, and a couple of the stronger students providing the colour commentary for the action that was taking place. To be honest, such an alternative form of assessment for multi-digit subtraction wouldn't be that hard to pull off. The hardest part, I told them, would be fitting 10000 to 14000 fans into a grade 3 classroom. To which they replied, without hesitation, "From what I've read and heard, classrooms are overcrowded to begin with…". Touché.