It is probably true that any significant body of computer software has bugs in it, where the size of *significant* is depressingly small. DragginMath is no exception. Careful design and coding practices, coupled with deliberate testing and retesting, help to reduce the number of bugs. Some will still get through. This is a software developer's first fact of life.

We believe it is important for software developers to be upfront about bugs, informing users of the problems we know about but have not been able to fix. In some cases, we don't yet know how to fix them. In other cases, we have not been able to schedule the time against other priorities. Some things that ought to be simple… simply aren't.

And then there are the bugs we don't yet know about. It is possible that you will be the first to find a bug in DragginMath. If you do, please tell us about it. Along with telling us *what went wrong*, we especially need to know *how you made it go wrong*. **We will be happy to hear from you.**

When holding an iPad or iPhone, the edge of a thumb or finger or part of the hand sometimes wraps around the edge of the device onto the screen's sensitive area. This can render DragginMath comatose. So… *don't do that!* We may have a solution to this problem, but we are not ready to release it.

We believe we have fixed the following bug. But it is the kind that is hard to reproduce even if you are trying, so we may never be sure. Please read about it anyway.

DragginMath builds pictures on the screen. Once they are complete, drag the parts of these pictures around with your fingertip to invoke the app's behavior. This kind of interaction is called a *Direct Manipulation Interface*. Software like this

continuously watches your fingertip to see what it is doing.

Rarely, DragginMath becomes *confused* or *unresponsive to touch*. When it is *confused*, you can still drag things around, but nothing happens when you try to make some algebraic change. When it is *unresponsive to touch*, it simply freezes, but it does not terminate. Taken together, we call these problems **Persistent Finger Confusion**. We have pursued them relentlessly, but they have been extraordinarily difficult opponents.

Usually, you can fix Persistent Finger Confusion by tapping the text field at the top of the DragginMath display. This starts a new math problem. It also resets everything in the app that tracks your touch. If that doesn't help, you will have to restart the app. Tap twice on your iPad/iPhone home button, then swipe up on the small DragginMath screen image you see there. This kills the app. Then start it again by tapping its icon in the display.

Persistent Finger Confusion happens mostly with new users. Unfortunately, because they are new users, they can't often tell us what they did that might have caused it to happen. **Fortunately, with more experience, this problem tends to disappear on its own.** Experienced users find it difficult or impossible to do this. This is why we have not been able to fix this problem: *we* can't make it happen, even when we try, and newer "problem users" don't remain in that category for long. **But it could still happen to you occasionally**, even if you are experienced. If it happens to you, we *really* want to know about it. **Please verify that you are not inadvertently touching the screen elsewhere**, as described in the previous section of this document. Coat sleeves might be a problem in this regard, depending on the type and weight of the fabric.

This release of DragginMath is a useful and usable product. It does not do *all* of algebra, but it does a lot of it. **You can expect upcoming releases to do more.** For what it does, we have tried to identify, address, and test all use cases. There are many, and we sometimes discover that we missed one. These are not really bugs, more like unseen opportunities. Of course, we are eager to find these. If you find one before we do, please let us know so we can add it to DragginMath's repertoire.

One of the design challenges of DragginMath is pairing the various possible drag gestures with specific rules of algebra. Some gestures could reasonably mean several things, and we as designers have to decide which meaning to use. *Our* design choice may not always be the one *you* might prefer in some specific case. When this happens, there is another way of approaching the issue that will give you what you want.

DragginMath implements inequalities: $< \leq \neq \geq >$. The deeper behaviors of these relations are not fully developed. In some cases, it is not obvious what their behavior should be in the context of DragginMath's interactive operator trees. Simple interactions with inequalities work correctly in our tests, but it is possible to drag many inequalities into questionable states. **Interactions with inequalities that have piecewise solutions are simply wrong in this release**, as DragginMath does not currently have a way to discover or represent these. Subsequent releases will improve this situation.

The usual backspace key icon in iPad/iPhone apps is ⌫, but font anomalies on older devices make this work badly in DragginMath keyboard layouts. We use ⬅️ instead. We have no plans to change this.

DragginMath overrides your Dark Mode setting, always running in Light Mode. We have no plans to change this.

DragginMath is intended for use on iPads, but it works on iPhones, too. The small screens on some devices can be a problem. You may need to rotate to the horizontal screen orientation to see all of the screen keyboard on some devices. With all of the different device models out there, just knowing what part of the screen is safe to use is surprisingly difficult. We continue to work on this.

When the primary ℹ️ screen or the ☰ screen are displayed, rotating the device may disable the controls within that screen. If you encounter this problem, tap OK to close the screen, then open it again in your preferred orientation. We continue to work on this.

Some ℹ️ screens have links to email and the web. On some devices, if you tap a link and then return to DragginMath, links don't work on that screen after returning to it. On other devices, all links continue to work as expected. These should all work (or not work) the same way, as the same code builds all ℹ️ screens. This demonstrates the amoral nature of software: if something *should* work but *doesn't*, it is only *doesn't* that matters. If you encounter this problem, tap OK to close the screen, then open it again and tap the link you want. We continue to work on this.

Something that is *not a bug*: DragginMath reduces fractions, roots, and logs by building a *factorization cache*, which computes the prime factorization of whole numbers. This

operation takes a long time, even on a computer. Therefore, when DragginMath computes this for a given number, it remembers the result so it doesn't have to do it again later. If a math problem needs the factorization of a large number, this cache can want to become quite large, perhaps larger than the available memory of your iPad/iPhone.

What happens when a number is too large? DragginMath terminates suddenly and without warning, and any recent work will be lost. You can then restart the app without any ongoing consequences, except that trying to solve the same problem again will have the same result. Of the things we *could* do to handle this, sudden termination might be the least obnoxious.

How large is too large? That depends on your device, and also on the memory requirements of other running apps. So we can't answer that question, because we have no way of knowing in advance. And if you kill or start another app on your device, then try it again, your personal definition of *too large* could change. On our test devices, we start to see this limitation somewhere around 1,000,000,000. It could be different for you.

Once again: this is *not a bug*. It is a *risk*. It is a risk you are *unlikely to encounter* if you work on problems presented by typical algebra coursework, or by life. In other words, unless you try to make this happen, you will probably never see it happen. But if you try to make it happen, you will easily succeed. Is it worth your time to do this? Probably not.