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# What does for every mean in math

Variables in mathematics, such as  $x$ ,  $y$ ,  $a$ ,  $b$ ,  $c$ , etc., are quantified with phrases such as "for all  $x$ ", "for any  $z$ ", "for every  $z$ ", "there is at least one  $a$ ", etc. "For any", "for all", "for every" all mean the same thing: something is true for EVERY object under discussion, WITHOUT EXCEPTION. If there is even one exception, the "for all" is deemed false. Here are some examples: For all  $x$ ,  $x=x$ . This is in fact an axiom about equality (assumed without proof as being basic to how we understand equality). Without exception, every object is equal to itself. For all  $x$  and for all  $y$ , if  $x=y$ , then  $y=x$ . This is another axiom about equality. If two objects are equal, it doesn't matter which is listed first in the statement of equality. For all  $x$ , for all  $y$ , and for all  $z$ , if  $x=y$  and  $y=z$ , then  $x=z$ . This is the transitive law (axiom) for equality. If  $x$  and  $z$  are both equal to  $y$ , then they are equal to each other. For all real numbers  $x$ ,  $x+0=x$ . For all real numbers  $x$ ,  $x^2=1$  or  $x=-1$ . For all real numbers  $x$ , there is a real number  $y$  such that  $x+y=0$ . This sentence mixes two kinds of quantification ("for all" and "there is"). With the "for all" coming first, the  $y$  that is required to exist IS ALLOWED TO BE DIFFERENT FOR EACH  $x$ . So, this statement is true because  $y=-x$  has the property that  $x+y=0$ . For all real numbers  $x$ , there is a real number  $y$  such that  $x*y=1$ . This sentence is false, because it happens to have just one exception: when  $x=0$ ,  $x*y=0$  for all real numbers  $y$  and there is no way to get some  $y$  so that  $0*y=1$ . For all non-zero real numbers  $x$ , there is a real number  $y$  such that  $x*y=1$ . This sentence is true, because for non-zero  $x$  we can let  $y=1/x$ . Note that  $x*(1/x)=1$ . In a probability space, for all events  $A$  and  $B$ ,  $P(A \cup B)=P(A)+P(B)-P(A \cap B)$ . This is a theorem of Math 371. For all  $E>0$ , there is some  $D>0$ , such that if  $|x-c| < D$  then  $|f(x)-f(c)| < E$ . This sentence is equivalent to the continuity of  $f$  at  $c$ . Unquantified Variables How does one read a sentence such as " $x=x$ ", which lacks any "for all" expression and lacks any "there is" phrase? Variables that lack quantification are said to be "free". Nevertheless, they are always understood as being "for all" sentences. So, " $x=x$ " means the same as "For all  $x$ ,  $x=x$ ". Suppose someone intends to show that every set is a subset of itself. Frequently, the writer will introduce a new variable (say,  $W$ ) with a sentence such as "let  $W$  be a set" and then show that  $W$  is a subset of  $W$ . The writer then stops. One way to read what the writer intended is this:  $W$  is a free variable and the writer shows  $W$  is a subset of  $W$ , without restriction on  $W$  except that it is some set. So, a rule of logic allows us to introduce the "for all" phrase (because  $W$  is free) to conclude that, for all sets  $W$ ,  $W$  is a subset of itself. "Not" applied to a "for all" sentence Consider a "for all  $x$ ,  $P(x)$ " where  $P(x)$  is some sentence about  $x$  (and whose truth value might depend upon  $x$ ; for different instances of  $x$ ,  $P(x)$  might have different truth values). Recall that, for this to be true, it must be true of every  $x$  without exception. So, for it to be false, one needs at least one exception.  $\text{not}[\text{for all } x, P(x)]$  means the same thing as  $[\text{there exists at least one } x \text{ such that } \text{not}(P(x))]$ . There might be more than one  $x$  such that  $\text{not}(P(x))$ ; there might be exactly one  $x$  such that  $\text{not}(P(x))$ . Either way, the "for all  $x$ ,  $P(x)$ " is false. Several "for all" expressions Consider two sentences: "for all  $x$ , for all  $y$ ,  $x+y=y+x$ " and "for all  $y$ , for all  $x$ ,  $x+y=y+x$ ". These mean the same thing: with repeated "for all" expressions referring to distinct variables, the order of the "for all" expressions is not important. This is NOT true for mixtures of "for all" and "there exist" expressions. @mathematicsprof/Twitter Some students love math — others not so much. In fact, some students find math to be difficult and dislike it so much that they do everything they can to avoid it. Math may feel a little abstract when they're young, but it involves skills they will need in life long after they're out of school. That makes math important for more than just a grade on a report card. Whether you're a parent helping your child at home or a teacher in the classroom, tackling the process with the right teaching methods can make a huge difference. If you're not sure where to start, take a look at these time-tested ways to help students with math. Build Confidence Some students who struggle to understand certain math concepts become discouraged and start believing that math simply isn't for them because they aren't any good at it. While it's certainly true that some students understand math concepts more quickly than others, everyone can learn math with the right techniques and tools. Work to build confidence from the outset — perhaps with a fun game that reinforces beginning math concepts — to ensure you take that fundamental first step to helping your child learn and succeed. @MathCoachCorner/Twitter Encourage Curiosity Big ideas in math tend to naturally inspire curiosity, but curiosity is a valuable tool even for basic concepts. For example, if students are struggling to understand how a fraction with a larger number on bottom could be smaller than a fraction with a smaller number on bottom, introduce some real-life items — like maybe large cookies — and let them explore the differences between dividing something into 10 pieces versus dividing it into four pieces. @MathCoachCorner/Twitter Additionally, letting their curiosity guide them gives them a chance to discover their own passions for the particular subjects they may enjoy most. Be sure to encourage curiosity and questions at all times, especially when you're helping them with new or challenging concepts. Raise the Bar Okay, every student won't fall in love with math, even after you build their confidence and show them they can learn it. As a result, some may try to get away with only doing the bare minimum to get a passing grade. Don't let them do it! Instead, raise the bar with even bigger challenges to send a powerful signal that they are always expected to do their best. @mathematicsprof/Twitter Plan in Advance For most parents, students bring home specific items as homework, and they simply need to be prepared to help with what they're given. However, teachers and parents who homeschool follow a curriculum. When that's the case, it's vital to look at the topics students need to know for their exams, and it takes some advance planning to make sure you cover all of them in detail. Don't forget to include plenty of time for questions and allow them time to truly understand the concepts before moving on to the next topic. @MathCoachCorner/Twitter Apply Math to Real-World Scenarios When you talk to students, it becomes clear that one of the key problems with math for many of them is that it just seems too abstract for them. They feel that way because they don't understand all the ways math relates to daily life in the real world — so show them! Applying equations, formulas and geometry to common tasks they can see and participate in helps students understand just how important math is in our lives. @mathematicsprof/Twitter Be Positive Kids' brains are like sponges, and they absorb all kinds of remarks and suggestions from adults — both positive and negative. It's critical to be vigilant about what you say when it comes to talking about math and helping them with it. Even if you start to feel frustrated yourself, take a short break to relax and then seek guidance from online sources or another person to help you figure it out. Above all, stay positive and don't express a negative attitude that your child is likely to mimic. With a positive approach, you might be surprised to see how much progress your child starts to make. @MathCoachCorner/Twitter Personalize Math Assignments Numbers sometimes work in very interesting ways. In short, that means some problems can be solved in more than one way. Giving students some control over how they learn allows them to adapt and incorporate their strengths, and it also conveys your belief in their ability. For example, instead of just giving them an exercise or worksheet to complete, you could prepare several different exercises and let them choose what they want to do. They are far more likely to be enthusiastic about a task they gave themselves. @memesxmoney/Twitter Prioritize Understanding, Not Memorization In the academic world, too much emphasis is sometimes placed on memorizing information for exams. That might work in a history class, but for math, it's critical to really understand the mathematical concepts to achieve long-term success. If you don't encourage understanding over memorization from the beginning, students could find themselves on shaky foundations as the math gets progressively harder. @MathCoachCorner/Twitter Reward Progress No matter what subject you're working on with your child or student, it's important to reward progress. In the sports world, this often comes in the form of medals or trophies. Don't put off giving them rewards for their hard work! They shouldn't have to wait until they achieve big things like getting A's on report cards and outstanding test scores. Reward your student as you go with simple but cool treats like setting up a math game to play on a computer or mobile device in place of a regular study session. They will enjoy it a lot more than a certificate or badge. @MathCoachCorner/Twitter Collaborate with Teachers and Parents Whether you're a teacher or a parent, it's always a good idea to collaborate with each other. This will keep you on track and help you get past hurdles quickly. Teachers should keep parents informed about exactly what they've been doing in class, while parents — who are generally the ones called on to help out at home on a more one-on-one basis — should seek guidance from teachers and inform them of any problem areas that are particularly challenging. @mathematicsprof/Twitter MORE FROM QUESTIONSANSWERED.NET

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