Who's Afraid of the Big Bad X?

X is a pronoun like 'me',
But more of an 'It' than a 'he'.
So why sit afraid
When that letter is made,
For a number is all it can be!   *July 2000*

Introduction

The most likely answer to the title question is just about everyone, at least when X is first introduced. Over time, most of us who are mathematically inclined overcome this fear, and the "big bad X" becomes an automatic part of our everyday life experience. Unfortunately, this has not happened for the majority of American adults who are presently in or about to enter America's workforce. And for those of us who understand the *power of X* as it is found in the *language of algebra*, we can only shudder about the future of our country as the whole world becomes increasingly technological and Americans become increasingly innumerate. To help combat the innumeracy problem associated with the "big bad X", this article presents an alternate pedagogical approach for introducing *algebraic variables*, or *unknowns* as they are sometimes called. This approach currently is being used by some Sinclair-Community-College instructors in two departments: Mathematics and Developmental Studies.

Long-Ago Dragons Still Alive

Have I always been a math aficionado? The answer is a resounding no! How and when I changed into one is a subject for another article. For now, let's travel back in time to late September 1961. I was then an entering freshman at Xenia (Ohio) High School, and, as such, was facing ninth-grade algebra.

There, I first met the dragon. The teacher, a kindly yet stern lady nearing retirement, wrote the algebraic expression $3X^2+7X$ on the board and promptly declared that X was an *unknown*. I froze dead in my tracks! My hands started to sweat; my knees, shook; and my heart, raced at the sound of the monstrous word *unknown*. To put this fear in perspective, I was a grade-schooler in the 50s, and many a Saturday afternoon brought cinema fun and excitement via such titles as It Came from Beneath the Sea; It, the Terror from Beyond Space; and It, the Unknown. And, in that long-ago moment, my 14-year-old mind was busy equating X to It per the following adolescent logic stream: X is an unknown; *therefore,* I cannot know anything about It; *therefore*, I cannot deal with It; therefore, I cannot learn It; therefore, I will flunk algebra; *and therefore*, I shall be grounded! Scary prospects indeed for one who definitely enjoyed the thrill of teenage mischief much more than the studious confines of home and classroom. Even today, I still maintain that the most horrifying description of X ever invented is the word *unknown*.

A few days later, the teacher redefined X to be a *variable*. I think this may have helped my understanding a wee bit, but, the new definition still had uneasiness about it. For a *variable* was a slippery thing—like the catfish I used to catch as a kid—and could wiggle out of your hands at any time. Wiggling catfish could also gore you if you were not careful in your handling, an unsettling attribute that I quickly imputed to X. Hence, I spent the rest of my high-school days living in uneasy fear of X (and its equally troublesome relatives Y, Z, W, etc.) since each of these had the power to sting you with an F or a D at any time. Granted, I dealt with X, but I really didn't understand what lurked behind the two unfortunate words—*unknown* and *variable*—until my college years. My high-school bottom line was simple:

X was to be avoided as much as possible outside the mandatory classroom (the dragon's lair); for the dragon called X was a scary thing, understood and tamed only by those geeky techno wizards who knew its secrets.

So, 43 years later, what is my experience as I stand on the other side of the desk and watch today's students encounter the dragon? Pretty much the same. I have seen grown men with biceps matching those belonging to California's current governor grovel at the sight of the beast. Men and women, young and old, have run away from the dragon's lair (some actually crying) vowing never to return. The real tragedy is that everything from the cell phone to the actual PC version of Dungeons and Dragons™ depends on the algebraic dragon for both product design and subsequent product operation, and those who fail to master the dragon are forever marginalized in our increasingly high-tech culture. Given the gravity of the present situation, is there anything we as teachers can do in order to help with the inculcation of X by eliminating this initial fear factor?

Enter the 'Pronumber'

About ten years ago, I started using a simple language metaphor in order to explain what is meant by X. But first, let's digress and revisit our elementary school English and mathematics training. We started our English training by learning two parts of speech, nouns and verbs. Specifically, we learned about *proper nouns*, specific persons, places, or things. Most of us can recall Ted, Sally, Dick, Jane, Spot, Boots, and America, all *proper nouns*. The other part of speech was the action word or *verb*; and, by using noun-verb combinations, we were able to construct little sentences such as "Jane sees Boots" and, by adding a bit more complexity, "Jane sees Boots run."

Adjectives further beefed up the complexity factor via such gems as "Young Jane sees big Boots." Slowly and surely, we added vocabulary, structure, and additional parts of speech to our mastery of English which we had to practice every day *both in school and out of school* as part of our general socialization.

Unbeknownst to us at the time, we were undergoing a similar process in arithmetic. Our first numbers were single digit numbers. As we progressed through elementary school, single digit numbers became multi-digit numbers, multi-digit numbers with decimals, and, finally, those dreaded fractions. These various sorts of numbers were inescapably linked in that all were still specific numbers, numbers that named a specific quantity. When performing my duties as an algebra instructor, I will give these specific numbers a new name, *proper numbers*. Moving ahead, you probably have already guessed the arithmetical equivalents to verbs in English. These are the four process symbols $+, -, \times,$ and $\div$; which, in arithmetic, describe a combining action between two *proper numbers*[1]. The equals sign $=$ is nothing more than the arithmetical equivalent to "is" or "are", two English verbs of being. Hence, to state that 1+3=4 is no more esoteric or complex than stating that "Ted and Sally are Ohioans." The big difference is that we were forced to practice our English in and out of the classroom on a daily basis—not so with arithmetic. Hence English (both standard and dialectal) had a better chance of becoming second-nature as we continuously lived, breathed, and practiced our native language.

[1] *The process symbolized by power-raising can be thought of as multiplicative shorthand, although some older authors (Ref 1) actually viewed it as a separate operation (called evolution) in its own right.*

Continuing with our language-building journey through grade school, we were soon introduced to the power of the pronoun (a non-specific noun). For those who attentively listened (I was the proverbial daydreamer), they soon learned that pronouns allow a person to make general statements like "everyone quickly leave the room" as opposed to specifically naming each individual in the room. Imagine the time that *specific naming* would take in an emergency, such as a fire or approaching tornado. Pronouns even allow us to gossip in a relatively safe fashion. I distinctly remember saying in my fourth-grade classroom "someone's armpit stinks." I then refused to name the actual person I dubbed "someone" for fear of getting a whoopin' after school. In summary, pronouns definitely enrich the English language by adding to the flexibility and power of the same. They do so, in part, by allowing for the making of general or categorical statements.

By now, I think you have made the connection. The *variable* or *unknown* called X is very easily understood as a nonspecific number, the arithmetical equivalent to an English pronoun. Again, in my role as an algebra instructor, I will call nonspecific numbers *pro-numbers*, or *pronumbers* if you will excuse my elimination of the hyphen, an exercise of poetic license. Just like English pronouns, pronumbers allow for increased arithmetical flexibility in that we can now formulate general or categorical relationships for several different pronumbers and proper numbers within an arithmetical expression. With X, Y, Z, etc. now understood by students in terms of the various named pronumbers, algebra is easily defined as follows:

Algebra is a generalized arithmetic which has been enhanced with a new part of speech, the *pronumber*. *Pronumbers* follow the same laws and structural rules as proper numbers and greatly increase our ability to quantify general phenomena.

Going back to the ninth-grade expression $3X^2+7X$, we immediately see one pronumber X, three proper numbers, and a plus sign. The pronumber X appears twice in two different terms where verbal actions are being performed in each term. In $3X^2$, the exponent 2 can be thought of as a reflexive verb that multiplies the pronumber X with itself. The result X^2 is further modified by the proper number 3 via an implied multiplication. In this context, 3 can also be thought of as a pronoun-modifying adjective. Similar observations can be made for the term 7X. Finally, the plus sign is a verb of addition arithmetically linking $3X^2$ to 7X to form the completed algebraic phrase[2].

Summary

Having employed this approach for several years, I can definitely state that it helps ease the transition from arithmetic to algebra by reducing "fear of X". But, does it create, in and of itself, highly-successful algebra students or is it a miracle cure? Unfortunately, the answer is no, and the reason can be quickly pinpointed by continuing our language metaphor.

[2] *Care must be exercised in drawing an exact parallel between algebra and English. As with any metaphorical comparison, there will always be unavoidable logical breakdowns in the details. Skill in applying the proposed construct (without going overboard) will naturally increase via on-the-job practice.*

The inculcation of language ability takes practice—lots of it. And as most everyday people would attest (if pressed), we Americans do not practice our arithmetic skills throughout our school years to the same degree we practice our English skills. Perhaps there are even some adults who now can go an entire day without once making change or making one checkbook entry. There is not much skill-building being done in situations such as these, hence, not much progress towards automatic arithmetical competence.

Algebra is an advanced language of precise quantification—made so by the introduction of the pronumbers—as opposed to the proto-form called arithmetic, a basic language of precise quantification. Thus, algebra can be expected to be more difficult to master; and mastery takes time, patience, and lots of practice when the dreaded subject is first introduced. Add to this dilemma the necessity of playing competency catch-up for those students who have sub-standard arithmetic skills for the previously cited reasons. The learning process is not unlike that experienced in Armed Forces foreign-language schools—totally boring but necessary immersion in the subject matter. As teachers, we are doing our students an injustice by watering down the importance of repetitious *skill-building* work, that proverbial and so important four-letter word! Make no promises except that "mastery will come if the effort is made." And, rewards will come to the masters, rewards in terms of true entry to our technological society and, hopefully, a greater degree of economic and life security. To close, a sonnet penned a few years ago seems to capture the sobering essence of this final thought.

Lion's Meat

The shadows of youth are all that remain,
My vague memories cold now bittersweet,
Days when my head was inflated and vain,
Times that I weep for and wish to repeat:
Not for small pleasures departed for good,
Not the lithe beauty, nor macho physique,
But to lock into place in times that I could
Skills vital today, the things one can keep.
No tools, no craft, no competence to sell...
These, the foundation of life's future years,
If had, bring assurance—happiness as well—
Of growth past forty instead of these tears!
   For skills offer hope, a chance to compete,
   Those skill-less are victims...and lion's meat.   *September 1997*

Reference

1. Klaf, A. Albert; <u>Arithmetic Refresher</u>; Reprinted by Dover Publications Inc.; 1964