Challenges in teaching laws of exponents and standard notation

Shivam Maurya

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1 Introduction

This report compiles challenges faced by a teacher in teaching laws and exponents due to lack of understanding of variables and shortage of applications into real life contexts.

2 Misconceptions due to lack of understanding of variables

Case 1 :

Look at the following law,

$$a^m \times a^n = a^{mn}$$

I found that some students take "mn" as number mn, not as $m \times n$. For example : a student may write $(3^4)^3$ as 3^{43}. Here, it may lead teacher to conclusion that student have not understood this law, **but here student have understood the law, but not the meaning of variable representation.**

Also,

$$a^m \times b^m = (ab)^m$$

Some students write $3^2 \times 4^2 = 34^2$

Case 2 :

Question : Finding value of m such that, $3^m \times 3^{-5} = 3^7$

Here, one student solved as follows,

$3^m = 3^7 \div 3^5$

Here, student have taken "-" from LHS transposed it two "+", but, **here, "-" is not an operation, it is not minus, it is a negative integer. So, we cannot transpose symbols**.

3 Misconception of generalization

In NCERT textbook (Class 7th and 8th), all laws are written whenever needed using two bases, for example :

$$a^m \times a^n = a^{m+n}$$

When students are given questions like

Simplify : $2^3 \times 2^4 \times 2^5$

Solution : $2^3 \times 2^9 = 2^{12}$

Upon asking students, are telling that they can apply law for two bases at once. They think that **they cannot extend the these laws for than more two bases**.

Reason : Because **we never discuss explicitly generalization of laws**, we do not need to use variable form of generalization, we can introduce idea taking examples of 2, 3, 4, 5 bases and we can show that this follows pattern.

4 Misconception of negative law

After teaching law,

$$a^{-1} = \frac{1}{a}$$

, I found that some students are using it as $a^{-1} = -a$. What can be there thinking behind it?

Reason : I am not able still found out exactly why student does like this? Probable reason may be student may be,

a^{-1}, here, -1 means multiplying a is raised to the power of 1 and adding negative sign with analogy of a^1, where 1 means multiplying a is raised to the power of 1 and adding positive sign.

5 Misconception in Standard Notation

Usally teacher and textbooks, uses larger number to introduce Standard Notation, which may lead to misconception that **standard notation is for larger numbers only**. For example, old ncert textbook (class 7th) uses the following example :

Mass of earth is 5,970,000,000,000, 000, 000, 000, 000 kg. We have already learnt in earlier class how to write such large numbers more conveniently using exponents, as, 5.97 × 1024 kg.

and, then in class 8th, it uses it for small numbers also.

But, in new NCERT textbook series, **it introduces this notation in class 8th and do not mention that it can be used for small numbers also, which may lead to misconception**. But, it does mention that The standard form or the scientific notation of any number is $x \times 10^y$**, where** $x \geq 1$ **and** $x < 10$**, and** y **is an integer.**

Also, some students write standard notation of 302400000000 as 3×10^{11} instead of 3.024×10^{11}.

Reason : student do not see much difference between 3.024 and 3.0

Also, as the name suggest, scientific notation, **student often thinks that it is applicable for science related concepts only,** but, I have used example of budget its application in social science also.

Example used :

In 2020, Udham Singh Nagar had 317000000 square meters of natural forest, and by 2024, it had lost 11800000 square meters of natural forest.

(i) What is the natural forest area of Udham Singh Nagar in 2024? Write this value into the standard form.

(ii) Find the ratio of the natural forest area in 2024 to the natural forest area in 2020. What are the reasons behind the loss of natural forests?

The annual milk production in Gujarat is around 17300000 metric tonnes, while India's total milk production is about 239000000 metric tonnes.

(i) Write the milk production of Gujarat and India in standard form.

(ii) Find the ratio of milk production of Gujarat and milk production of India. What does the value of ratio signify?

6 Conclusion

Chapter "Power Play" (also known as laws and exponents in old NCERT textbook) poses many challenges to teacher, as it is at the intersection of understanding of variables, simple equations and decimals. So, a teacher needs to design worksheet and pedagogy in such a way that it address these challenges.