

Fun Way or Run Away: Using Multimedia Technology (with Cartoons and Pictures) for Effective Teaching in Mathematics

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Abstract

There is a major concern that the students doing major in mathematics or in mathematics based field should be prepared more effectively while studying mathematics courses. These courses can be at undergraduate/postgraduate level. This manuscript focuses on the development of an instructional technique to effectively teach mathematics to students using multimedia technology leading to concept clarity and making it fun but not a boring subject.

Keywords: Fun way, Run away, Effective Mathematics Teaching, Multimedia Technology

1. Introduction

At different levels of teaching whether school, college or university, the mathematical courses are taught mostly by using chalk/ board method or marker/white board method. If multimedia technology could be used effectively along with chalk/board or marker/white board method then concepts could be more clarified and *using pictures/cartoons* can further develop interest among the students.

With the use of multimedia/technology time spent in writing on board will be saved in explaining the concepts and the time spent to copy from the board will be spent in understanding the concept. Key points/working, where required, can be written/done on board respectively.

Effective use of technology showing detailed calculations, proofs with integration of animations, pictures and cartoons into mathematics courses can enhance the conceptual understanding and interest in mathematics. This further *removes the misunderstanding* that "Mathematics is a dry subject".

In many universities the courses offered by the mathematics departments are not just for the mathematics majors but engineering, economics, natural sciences, social sciences and other disciplines. When the material in such courses is not taught in an interesting way, just memorization of formulae, or *too speedy* then the students (from other disciplines), who may have sound mathematical skills, are unable to grasp the concepts and sometimes leave mathematics saying it is just rote learning.

In this manuscript I will explain the instructional technique by giving an example to solve an Ordinary Differential Equation using "Laplace Transform" using multimedia technology. This technique proved to be useful not only for new students but also for those students who already studied same topics where multimedia technology was not used at all.

Use of multimedia technologies is an important part of research; see [2], in which significance of multimedia technologies training is discussed for teaching purposes. In that research difference in learning satisfaction was clearly indicated by concluding that the coursework with multimedia technologies produced greater satisfaction than with traditional learning methods. **After the relevant references all the websites have been acknowledged regarding 15 pictures/cartoons (used in sections 2 and 3).**

2. Why Multimedia Teaching Technique is More Effective (Fruitful) to Teach Mathematics than Traditional Teaching Techniques?

This is the key question to be discussed here and in section 3 that will be illustrated with an example. The following points must be followed to achieve this important goal:

1. In multimedia lectures **ANIMATIONS/CUSTOM ANIMATIONS** must be used so that one or a few lines/steps/pictures/cartoons should appear at a time but not the whole slide if whole slide appears on one click then it won't be easier for the audience/students to grasp the concepts/ideas.

ANIMATIONS is an inbuilt feature for example in Microsoft Power Point by which different objects (equations/pictures/sentences) appear as moving objects.

2. Another benefit of using animations is if students couldn't understand a few steps then those steps could be erased, reproduced and explained by a few clicks, which is NOT possible on (chalk/marker) board method. Any slide/lecture could be reopened to revise the *previous* concept *in detail* which is again not easily possible while teaching everything on chalk/marker board method.
3. While projecting multimedia images on the white screen it is always helpful to use pointer/laser pointer to indicate the points/concepts under discussion so students/audience should know where to concentrate. Color coding always helps to concentrate on main points. Preferable fonts are BLACK, RED and BLUE with WHITE background.
4. There shouldn't be any misunderstanding that we are not going to use white board/black board at all. Key Points/working can be written/done on board. But there will be no need to write every detail as it is already available

on multimedia slides. Points from previous slides should be mentioned on board which are going to be used on the next/subsequent slides. Any step/solution to problem missing on slides could be done in detail on board but it is better for students to understand first and write after the explanation of the instructor. It is also responsibility of the instructor that he/she shouldn't explain quickly and give reasonable time to students to understand and copy from board.

5. Basic concepts must be clarified otherwise advance topics are not understandable and problem solving skills won't develop. At university level teachers shouldn't say that was done at college level and won't be discussed here. This doesn't mean to explain the college syllabus fully but that very concept should be explained which is being used currently. This is explained by an example in section 3.
6. Teaching lesser contents with in-depth knowledge at a reasonable speed is much better than covering too many contents at a very fast speed. This is a problem worldwide even if teachers have an excellent command over the subject but they teach very fast without dropping down at the students' level then majority of students fail or learning process of students suffers a lot.
7. With reference to point no. 6 it is really important that full detail must be given on multimedia slides without missing the steps otherwise in-depth knowledge won't be transferred into the mind of students. Instructors who are using only headings/results/bullets are not making proper use of multimedia. Giving full details do require time and hard work but this increases the learning process of the students.
8. After the class/classes, all teachers should self-assess, by asking themselves an important question "Can I understand myself (as a student) if anyone teaches the way I teach? It has several benefits like one improves his/her teaching on his/her own without any guidance from others by thinking "I should have dropped down myself to students' level", "I went too fast in that topic", "I didn't explain that topic fully so I should explain it again", "I solved that problem by a difficult method but easier methods are available as well" and so on.
9. One major benefit of multimedia teaching is it saves time and energy for both teachers and students. Instructors can save their time and energy (to be consumed in writing on board) in explaining the concepts. Students can save their time and energy (to be consumed in copying from board) in understanding the concepts.
10. Soft copies of lectures/important handouts can be saved on pen drives instead of carrying hard copies. During the course students can keep hard copies but in the long run soft copies are much better to read/carry whenever required like going for higher education abroad or while doing a job and an old concept needs to be revised. Right from school level students carry big bags on their backs which is really hectic and one could think as an open minded person that putting soft copies on a **pen drive**



Is much better than **carrying bundles of hard copies** as shown in picture below:



11. By using colorful slides/multimedia one can draw diagrams (*difficult to do on board*) by which explaining the concepts becomes easier. For example see [1].

3. Fun Way Based Approach for Teaching Mathematics to Students at University Level Using Multimedia

As discussed in the previous section we have to keep several things in mind to use multimedia technology for effective teaching in mathematics. In this section I will illustrate this instructional technique by solving an "Ordinary Differential Equation" using the "Laplace Transform". The topic of "Laplace Transformation" is covered in 250 minutes (5 sessions of 50 minutes each) by the following 5 steps:

- (1) Starting by showing the *picture* of **Pierre-Simon marquis de Laplace (1749-1827)** French *Mathematician, Statistician, Physicist and Astronomist* who actually developed that method. Such information further motivates the students that with strong mathematical background one could explore other fields as well.



Definition is discussed as the Laplace Transformation $f(s)$ of a given function $F(t)$ is given by

$$f(s) = L\{F(t)\} = \int_0^{\infty} e^{-st} F(t) dt = \lim_{M \rightarrow \infty} \int_0^M e^{-st} F(t) dt$$

Explaining the concept of improper integral (as upper limit approaches infinity although covered in the pre-requisite).

(2) Using the above definition the following values are calculated in full detail using animations:

INVERSE LAPLACE TRANSFORMATION	LAPLACE TRANSFORMATION
$F(t) = L^{-1}\{f(s)\}$	$L\{F(t)\} = f(s)$
(1) $F(t) = 1$	$\frac{1}{s}, s > 0$
(2) $F(t) = e^{at}$	$\frac{1}{s-a}, s > a$
(3) $F(t) = \cos(\omega t)$	$\frac{s}{s^2 + \omega^2}$
(4) $F(t) = \sin(\omega t)$	$\frac{\omega}{s^2 + \omega^2}$
(5) $F(t) = Y'(t)$	$sy(s) - Y(0), y = L\{Y(t)\}$
(6) $F(t) = Y''(t)$	$s^2 y - sY(0) - Y'(0)$

where $Y'(t) = \frac{dY}{dt}$, and $Y''(t) = \frac{d^2Y}{dt^2}$.

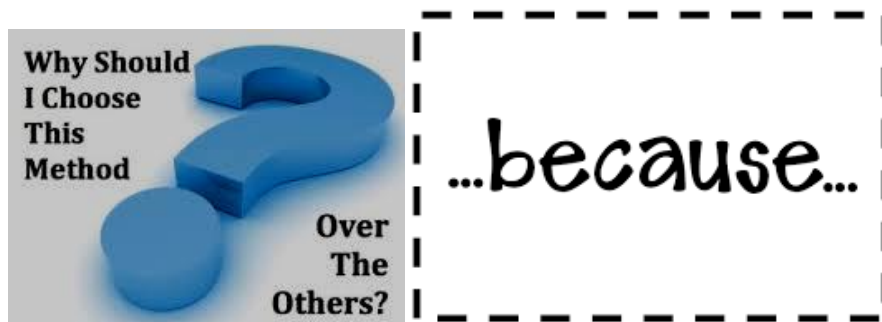
In order to derive the Laplace transformations of trigonometric functions (items (3) and (4)) in the above table we need background from the complex numbers/analysis. Instead of saying that students did it in college or it will be done in "Complex Analysis" course I start from scratch and start with the definition of real number, imaginary number, complex number, equal complex numbers, complex conjugates, Maclaurin's expansion leading to the derivation of Euler's formula and then derive the Laplace transformations of trigonometric functions.

Regarding items (5) and (6) of the above table students must be motivated first that we need the Laplace transformations of derivatives as we have to solve the differential equations. In order to find the Laplace transformation of first derivative (item (5) of the above table) we need integration by parts. Unhappily I saw several students saying "Integration by Parts" has no logic so bearing this in mind I do the proof of "Integration by Parts" and then derive the Laplace transformation of the first derivative.

(3) The proofs of the following properties of the "Laplace Transformation" are derived in detail using animations which will be used to solve ordinary differential equations.

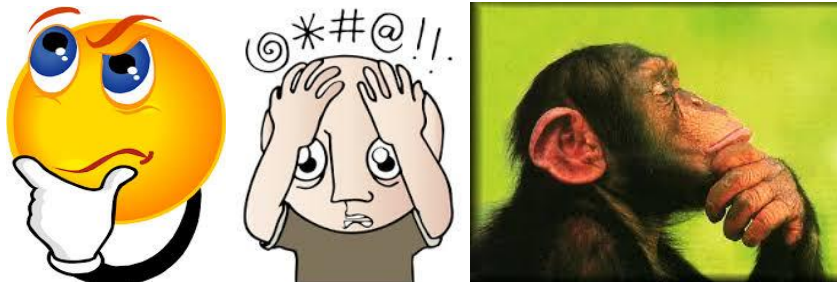
If $L\{G(t)\} = g(s)$ and $L\{F(t)\} = f(s)$
ARE THE LAPLACE TRANSFORMATIONS OF $G(t)$ AND $F(t)$ RESPECTIVELY THEN
 (1) $L\{F(t) + G(t)\} = L\{F(t)\} + L\{G(t)\}$
 (2) $L\{cF(t)\} = cL\{F(t)\}$, c is an arbitrary constant.
 If $f(s) = L\{F(t)\} = \int_0^{\infty} e^{-st} F(t) dt$, then $F(t)$ is
THE INVERSE LAPLACE TRANSFORMATION OF $f(s)$ AND IS WRITTEN AS $L^{-1}\{f(s)\} = F(t)$, THEN
 (1) $L^{-1}\{f(s) + g(s)\} = L^{-1}\{f(s)\} + L^{-1}\{g(s)\}$
 (2) $L^{-1}\{cf(s)\} = cL^{-1}\{f(s)\}$

(4) Before solving the ordinary differential equations by Laplace transform I ask general questions from students so they know why "Laplace Transformation" is preferable over other methods like "Variation of Parameters" and "Undetermined Coefficients". To make it more interesting I use cartoons and pictures and ask in the following way using animations:

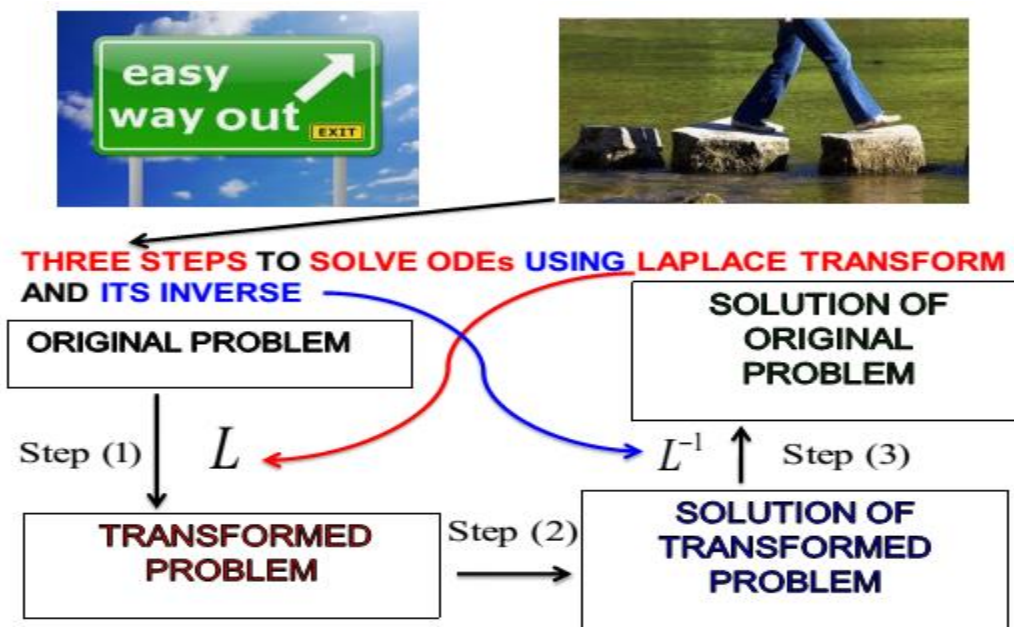


LAPLACE TRANSFORM TRANSFORMS THE ORDINARY DIFFERENTIAL EQUATION INTO ALGEBRAIC EQUATION WITHOUT DERIVATIVES AND INITIAL CONDITIONS ARE AUTOMATICALLY INCORPORATED (INCLUDED) INTO THE ALGEBRAIC EQUATION FORMED. USE OF LAPLACE TRANSFORMS TABLE CAN FURTHER SAVE TIME.

Then the next question is asked how to use “Laplace Transformations” to solve the ordinary differential equations? After that for fun I say to **THINK** with a preferable thinking style as shown below:



Then I tell an easy way out and describe “Three Steps” to use Laplace transformation for solving an ordinary differential equation using pictures and animations as shown below:



(5) Then finally I solve the problem by following the above mentioned three steps.

Let us discuss one problem here. Over here I would like to mention that in a previous lecture the concept of “Linear Ordinary Differential Equation” was explained fully (which is mentioned below in the problem).

SOLVE THE FOLLOWING LINEAR ORINARY DIFFERENTIAL EQUATION WITH CONSTANT COEFFICIENTS USING LAPLACE AND INVERSE LAPLACE TRANSFORMATIONS:

$$Y'' - 3Y' + 2Y = 12e^{4t},$$

$$Y(0) = 1,$$

$$Y'(0) = 0.$$

Keeping the size of font larger is always better so that even in large classes everything should be visible to the students in a comfortable way. Here for one complete multimedia power point slide I give step by step detail how different equations/sentences appear using animations and then show the slide as a whole.

Step 1

APPLY LAPLACE TRANSFORMATION ABOVE AND OBTAIN

After that the following step appears: $L\{Y''\} - 3L\{Y'\} + 2L\{Y\} = 12L\{e^{4t}\}$

Then Laplace transformation of every function, (from table in step (2)) is shown using **red arrows**, which also appear step by step using animations as shown below:

$$L\{Y''\} - 3L\{Y'\} + 2L\{Y\} = 12L\{e^{4t}\}$$

$$\therefore \{s^2 y - sY(0) - Y'(0)\} - 3\{sy - Y(0)\} + 2y = 12\left(\frac{1}{s-4}\right)$$

The given values of Y and its derivatives are then substituted and next step appears as

$$\therefore \{s^2 y - sY(0) - Y'(0)\} - 3\{sy - Y(0)\} + 2y = 12\left(\frac{1}{s-4}\right)$$

$$\therefore \{s^2 y - s(1) - 0\} - 3\{sy - 1\} + 2y = 12\left(\frac{1}{s-4}\right) \quad (1)$$

**TRANSFORMED
PROBLEM**

The whole slide appears like this:

SOLUTION:

$$Y'' - 3Y' + 2Y = 12e^{4t}, Y(0) = 1, Y'(0) = 0$$

Step 1 APPLY LAPLACE TRANSFORMATION ABOVE AND OBTAIN

$$L\{Y''\} - 3L\{Y'\} + 2L\{Y\} = 12L\{e^{4t}\}$$

$$\therefore \{s^2 y - sY(0) - Y'(0)\} - 3\{sy - Y(0)\} + 2y = 12\left(\frac{1}{s-4}\right)$$

$$\therefore \{s^2 y - s(1) - 0\} - 3\{sy(s) - 1\} + 2y = 12\left(\frac{1}{s-4}\right) \quad (1)$$

**TRANSFORMED
PROBLEM**

The same method (step by step appearance of objects using animations) is used to make the subsequent slides with detailed calculations. The subsequent slides are shown below:

Step 2 SOLVE (1) FOR $y = y(s)$

$$\therefore (s^2 y - s) - 3\{sy - 1\} + 2y = 12\left(\frac{1}{s-4}\right) \quad (1)$$

$$\therefore (s^2 - 3s + 2)y - s + 3 = 12\left(\frac{1}{s-4}\right)$$

$$\therefore (s-1)(s-2)y = 12\left(\frac{1}{s-4}\right) + s - 3$$

$$\therefore (s-1)(s-2)y = \frac{12 + s^2 - 3s - 4s + 12}{s-4}$$

$$\therefore (s-1)(s-2)y = \frac{s^2 - 7s + 24}{s-4} \Rightarrow y = \frac{s^2 - 7s + 24}{(s-4)(s-1)(s-2)}$$

**SOLUTION OF
TRANSFORMED
PROBLEM**

In step (2) the factorization $s^2 - 3s + 2 = (s-1)(s-2)$ is done on board as well.

Although it looks strange at "University Level" that teacher is doing such steps but an exceptional teacher totally removes the fear/anxiety from the minds of students by explaining everything and then the students (maybe with poor back ground) are motivated to work hard by thinking that now it's their responsibility to put in efforts as teacher performed his/her duty sincerely. The **subsequent slides** explaining the third step of "Laplace Transformation" with pictures/cartoons are given below:

$$y = \frac{s^2 - 7s + 24}{(s - 4)(s - 1)(s - 2)} \quad (2)$$

Step 3

APPLY INVERSE LAPLACE TRANSFORMATION TO (2)

BUT HOW AS (2) IS COMPLICATED?



BE HAPPY



MAKE PARTIAL FRACTIONS IN (2), WHICH MEANS TO FIND A, B, C SUCH THAT

$$\text{Let } \frac{s^2 - 7s + 24}{(s - 4)(s - 1)(s - 2)} = \frac{A}{s - 4} + \frac{B}{s - 1} + \frac{C}{s - 2} \quad (3)$$

Kindly notice that use of pictures and cartoons makes the course interesting and students remain attentive instead of losing interest or getting bored and in addition "Partial Fractions" are also being done here instead of saying you did that in college and do yourself. Please see the detail on the following slide:

$$\text{Now } y = \frac{s^2 - 7s + 24}{(s - 4)(s - 1)(s - 2)} = \frac{A}{s - 4} + \frac{B}{s - 1} + \frac{C}{s - 2} \quad (3)$$

MULTIPLYING (3) with $(s - 4)(s - 1)(s - 2)$

$$\Rightarrow s^2 - 7s + 24 = A(s - 1)(s - 2) + B(s - 2)(s - 4) + C(s - 1)(s - 4) \quad (4)$$

$$\text{For } s = 4 \quad (4) \Rightarrow 12 = A(3)(2) \Rightarrow A = 2$$

$$\text{For } s = 1 \quad (4) \Rightarrow 18 = B(-1)(-3) \Rightarrow B = 6$$

$$\text{For } s = 2 \quad (4) \Rightarrow 14 = C(1)(-2) \Rightarrow C = -7$$

Using A, B, C in (3) WE OBTAIN

$$y = \frac{2}{s - 4} + \frac{6}{s - 1} - \frac{7}{s - 2} \quad (5)$$

APPLY INVERSE LAPLACE TRANSFORMATION TO (5)

$$L^{-1}\{y\} = 2L^{-1}\left\{\frac{1}{s - 4}\right\} + 6L^{-1}\left\{\frac{1}{s - 1}\right\} - 7L^{-1}\left\{\frac{1}{s - 2}\right\}$$

$$\therefore Y(t) = 2e^{4t} + 6e^t - 7e^{2t} \quad \text{SOLUTION OF ORIGINAL PROBLEM}$$

$$\therefore L\{e^{at}\} = \frac{1}{s - a}, \quad s > a$$



In the above slide the result $\therefore L\{e^{at}\} = \frac{1}{s - a}, \quad s > a$ is used directly, however, as indicated in

Step (2) (Table of Laplace Transforms) of ongoing section it was derived in detail. While applying here directly I do tell students that they don't have to memorize the formula but they should know the derivation. At this stage I always ask if derivation is not clear then I can open that Lecture/slide on Multimedia and revise the derivation. On chalk/board method it is not possible to do derivation again and again so mostly teachers give reference instead of explaining again. The slide with detailed derivation of that formula is shown below:

EXAMPLE: FIND THE LAPLACE TRANSFORMATION OF THE FOLLOWING FUNCTION

$$F(t) = e^{at}, \text{ for } s > a$$

$$\text{SOLUTION } \because f(s) = L\{F(t)\} = \int_0^{\infty} e^{-st} F(t) dt = \lim_{M \rightarrow \infty} \int_0^M e^{-st} F(t) dt$$

$$\begin{aligned} \Rightarrow L\{e^{at}\} &= \int_0^{\infty} e^{-st} e^{at} dt = \int_0^{\infty} e^{-(s-a)t} dt = \lim_{M \rightarrow \infty} \int_0^M e^{-(s-a)t} dt \\ &= \lim_{M \rightarrow \infty} \int_0^M e^{-(s-a)t} dt = \lim_{M \rightarrow \infty} \left[\frac{e^{-(s-a)t}}{a-s} \right]_0^M = \frac{1}{(a-s)} \lim_{M \rightarrow \infty} \{e^{-(s-a)M} - 1\} \\ &= \frac{1}{s-a} = f(s), \because \lim_{M \rightarrow \infty} \{e^{-(s-a)M}\} = 0 \text{ as } s > a \\ \therefore L\{e^{at}\} &= \frac{1}{s-a}, \text{ for } s > a, \text{ ALSO } F(t) = e^{at} = L^{-1}\left\{\frac{1}{s-a}\right\} = L^{-1}\{f(s)\} \end{aligned}$$

4. Students' Feedback

The following table is showing the response of students after studying Mathematics Courses on Multimedia

1. TABLE	
Serial No.	Selected Students' Responses Regarding Multimedia Teaching Method
1.	The use of multimedia is a best way of teaching students and other teachers should follow this method.
2.	I am really thankful to the instructor and his effective way of teaching using multimedia, it has alleviated (reduced) my fear of long and scary looking mathematical equations. I am impressed the way he concentrates on the proofs and roots of the concepts.
3.	The way of teaching with multimedia is really effective and concepts got very easy to grasp (grab).
4.	Using multimedia in classroom is really a good teaching technique, so we don't have to put efforts in writing and concentrate fully on learning.
5.	The use of multimedia is very effective to teach mathematics. Instructor made the course easy and interesting through multimedia using animations, details, pictures and cartoons.
6.	The awesome teaching method using animated power point slides is highly appreciated. Instructor focuses on clearing the concepts rather than completing the course, encourages discussion, by putting more efforts than other professors.
7.	Being a non-math major I was of the mind that mathematics is a dry subject but after studying "Ordinary Differential Equations" on multimedia with animations, detailed explanations including pictures and cartoons I was motivated towards fruitful learning and realized that my thinking was wrong and mathematics is a very useful and an excellent subject with full of logics, fun and critical thinking.

5. Conclusions

- Use of multimedia and colorful slides makes easier to grasp concepts, shows dedication and sincere efforts of instructor to ensure that every student is following the class. In addition at undergraduate level students must be encouraged towards proof writing and to solve exams without the unnecessary aids like open book/notes.
- If mathematics is a dry/unpopular subject then why to study it? Unhappily mathematics teachers themselves have made this subject unpopular. In order to make it popular one has to use innovative teaching methods. Concept clearing gives a good knowledge of things, which students assumed to be true, which could be done in a better way by using innovative technology based techniques.
- Learning the concept is more important than getting the answers right. While teaching mathematics especially to non-math majors like engineers [1] a work plan should be given for accurate and error free calculations in order to use them for practical projects like constructing roads, bridges and buildings. There is no compulsion to adopt these innovative teaching techniques but good mathematics teachers should adopt such technology based techniques which I experienced and discussed here. Otherwise traditional teaching methods are there by which majority of the students are of the mind that it is a dry and useless subject. It is the demand that mathematics should be taught in a way so it no more remains a dry and unpopular subject.
- Training of teachers is necessary. Services must be offered in teaching methodologies of mathematics to teachers from school to university level. If at school level mathematics is taught by multimedia but not by traditional methods (by forcing rote learning) then not only students learn mathematics happily but want to learn more otherwise they run away.
- With reference to point (4) in training workshops one can solve difficult problems by traditional methods and also by multimedia so teachers (and maybe students) can realize which method is better. Emphasis of such teachers' training will be to invest time and energy to improve the teaching methodology and making the subject popular.

- In order to check the conceptual understanding critical thinking based assignments could be given. First instructor should solve similar problems in the class, and then ask students to solve under the supervision of instructor, and finally students should enjoy solving the problems on their own. In order to make the students comfortable assignments' solutions could also be given provided students only consult them if they are stuck while solving on their own. If students are going to consult the solutions directly without putting any efforts to solve them then learning process for concept clearing might suffers and again mathematics remains a dry subject. See also the reference [3] which discusses an interesting study of issues related to analyze the problems produced by future expected teachers regarding addition and subtraction operations with integers.

References:

1. Dr. Wasiq Hussain "An Application Based Approach to Teach Mathematics to Undergraduate Students Especially Engineers" Weber Educational Research & Instruction Studies (ISSN: 2449-1608), Vol. 1 (5) 2015, Article ID weris_147, 301-306, 2015.
2. Fulei Zhang "Significances of Multimedia Technologies Training" 2012 International Conference on Medical Physics and Biomedical Engineering. Published by Elsevier B.V. Selection and/or peer-review under responsibility of ICMPBE International Committee.
3. Cemalettin ISIK "Analyzing Problems Posed by Prospective Teachers Related to Addition and Subtraction Operations with Integers" Higher Education Studies; Vol. 8, No. 3; 2018. Published by Canadian Centre of Science and Education.

Acknowledgement of Pictures and Cartoons Websites:

Author sincerely acknowledges the availability of pictures and cartoons (used in sections 2 and 3) at the following websites:

1. <https://www.flipkart.com/transcend-jet-flash-340-otg-16-gb-drive/p/itm3qy9ggkgsqh>
2. <https://navbharattimes.indiatimes.com/education/education-news/saturday-to-be-no-bag-day-in-govt-schools/articleshow/58654838.cms>
3. https://en.wikipedia.org/wiki/Pierre-Simon_Laplace
4. <http://emotionalhealth.net.au/wp-content/uploads/2014/02/Why-this-method-300x228.jpg>
5. https://lh3.googleusercontent.com/pNdMYIRGCGaXwMm11cOq-2wTt6jdvfe6iTtnx7Xi2_KiJMrF6c7vCiKw3PD0zvXLBHj7Q=s125
6. <https://lh3.googleusercontent.com/vPAFPECZBVS27xC1flwwMdmPPcFKwW9WWUYuaOgvBsJwdybB5wdmx8KzCuD-PGKrsuww=s85>
7. https://lh3.googleusercontent.com/6Dm2CUSUzDbrBmqRH4cvv252Uz9S1h6A2esFj7-cqabm63J-Gzd7L8pSU9_3CXyqbBLdA=s85
8. https://lh3.googleusercontent.com/Vv6nemA5sWeFelc7iUVxQ6cUKijcnpvX6PKIrcBrRSa8QD8u3WQWaGoyzjt0c_I9PKfu=s114
9. https://lh3.googleusercontent.com/YksR4ftDVO4_eqEPdf1xSh5A8vUcLYgGP6_Wn8RboIyHJKKvYauNk6h9tkzPIUFH4BI-zA=s128
10. https://lh3.googleusercontent.com/oSetLVih75nx5DnmZrCWb-_ustQ0dTVJcV0ghSOpodcEPH_hYYOC3EocKfjaGm078R3TrdY=s151
11. https://lh3.googleusercontent.com/ztcVOOFhE1ib_PUvotXG9QrAvXJB_BZeXpdGiSpk35Cy_zCFk03F3vXLkPO3IPQKZBCajAI=s167
12. https://lh3.googleusercontent.com/IYvfNT-fUebgEblSjBqVw_4zuRs2hEgD3H0wWaEToJS9SoRK04KR9WsB01Nhu8rWiDRjm7I=s85
13. https://lh3.googleusercontent.com/cVXH5tUqGoD-QFR3HeP7hRR0jECi60jvC_Klj87tlBApgN1jBBF4qj5Htace_E0ZrV_iHM8=s88
14. https://lh3.googleusercontent.com/rAsGiDKbErzoYqYm0ogrZq0rZGcUM0tcNkfELnIA6YwE9gLm_y4Q-42sxsnrM5uESpo38_Y=s85
15. https://lh3.googleusercontent.com/9bXdzNTKpVWExkQ0VutyW2F3FpJ_5vJt8d8d7zgO6S0_ND4NhiDAsXyJSNUFqlshCfUGkA=s113