Enhancing Virtual Labs Usage in Colleges

by

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***Abstract*—Virtual Labs is an MHRD (Ministry of Human Resource Development, India) initiative in which over 1100 virtual experiments are freely available to engineering students across India and the rest of the globe to access and learn. Until the beginning of 2018, the lab usages by students were mostly in the push mode during the workshops. The average usage per workshop was significantly low, at about 8 usages per student. Interventions were proposed in the process to improve the usage by enhancing 'Arousal' and 'Choices' as students' motivation. Qualitative observation of the results shows that students conducted more than the requested 15 experiments, along with the expectation of instant appreciation and recognition. This change in the process to create extrinsic motivation increased the usage per student from 8.62 to 19.7. self-reported motivation levels of students after doing the experiments improved from 5 to 8, 10 being the highest on the scale. There was a reduced variability represented by the coefficient of variation changing from 51.9% to 21.39%.**

***Index Terms*—Virtual Labs, Usage, Feedback, Motivation**

I. Introduction

India has over 1.4 million engineering students graduating from over 3100 engineering colleges [1]. Lack of quality lab infrastructure in many colleges is a concern. To address this limitation, the Ministry of Human Resource Development (MHRD), has implemented Virtual Labs project [2]. The major objectives, of Virtual Labs are -

- To provide remote-access and simulation labs in various disciplines of Science and Engineering.
- To enthuse students to conduct virtual experiments by arousing their curiosity. This would help them in learning basic and advanced concepts through remote experimentation.
- To share costly equipment and resources in virtual form, which are otherwise available to limited number of users due to constraints on time and geographical distances.

There are about 1100+ experiments across 114 labs developed by 11 top engineering institutes in 9 disciplines. These labs are deployed on cloud environment for scalability and are available freely available online. The initiative has an outreach activity to enthuse students and spread the usage through face to face workshops conducted in colleges with the faculty and students. Colleges act as nodal centres to evangelize Virtual Labs, more than 3500+ workshops were conducted to increase the usage of labs by 750+ nodal centres. Over 36,00,000 usages from over 6,00,000 participants were recorded with the use of labs since 2014.

The Virtual Labs under The National Mission on Education through Information and Communication Technology, MHRD, Government of India

II. Conducting Workshops and Feedback

To spread and promote the usage of Virtual Labs, outreach field engineers, in liaison with colleges, conduct workshops in which students are explained how to use the portal, access experiments and perform experiments of their choice. After this, students were asked to perform as many experiments as they want in the domain of their choice and record their feedback on paper feedback forms. This form is the basis for recording the usage and other metrics that track the Virtual Labs outreach and spread. This push mode of outreach is supported by a faculty from colleges who act as Nodal Coordinator (NC). These NCs spread the usage through workshops inside their colleges as well as other colleges nearby with interest to promote Virtual Labs. The feedback form captures information on (a) the availability of the experiments for use by the students (b) experiments that work well (c) students' preferences for disciplines and experiments, and (d) students' intent to use the experiments after the workshops. It also captures students' feedback on their interest and areas of improvement in Virtual Labs.

III. Feedback from outreach before any intervention

The feedback from outreach before any intervention showed that the usages and the motivation of the students in performing the experiments was low. This resulted in low participation of the students in workshops. The motivation of the paper is to identify and validate "Internal and external factors stimulate desire and energy in people to be continually interested and committed to a job, role or subject, and make an effort to attain a goal" [3].

The average strength in the engineering colleges that the outreach team visited is about 4-5000 students. The average number of students participating in a workshop was

approximately 102 and an average usage of labs per college as 918, this came from multiple sessions. The figure 1 shows the distribution of participants in the workshops across different colleges. The sample size for this data is 17 colleges with 80% confidence level and 10% error rate. During the workshops conducted, students were given a free hand to conduct experiments of their choice, within the duration of the workshop, which was typically 2-3 hours. From the point of view of the students, those who were interested continued for a long time but for many others there was no motivation to continue. The workshops were demonstrations with no compulsion to use Virtual Labs.

This resulted in a high variation in the number of experiments performed by students in each college. The coefficient of variation (CV) for this was 51.9%, a relatively high value. A lower value indicates reduced variability and ensure predictability. Figure 1 Shows the distribution of usage per student in Virtual Labs Workshops before the intervention. (Source: Data is taken from Virtual Labs Outreach Portal) [4] An important factor that seemed to

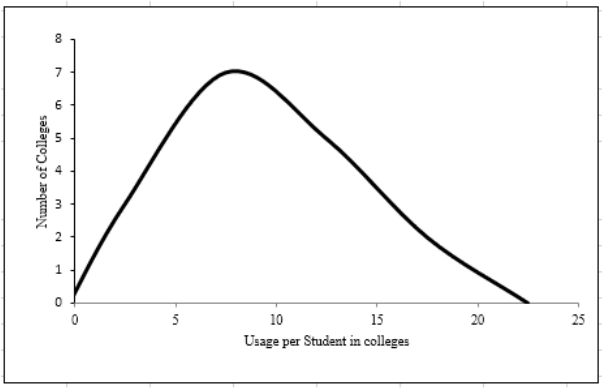

Fig. 1. Distribution of usage per student

influence was the motivation levels of the students and faculty - intrinsic or extrinsic. Though Virtual labs were made available to the students as a supplementary facility to improve their learning and act as a complete Learning Management System accessible from anywhere, there was a gap observed in the motivation levels of the students. One reason for lack of extrinsic motivation in the students and the college managements, was possibly, that there was no compulsion that Virtual Labs have to be used. From informal discussions this was observed to be true, as the students were busy and occupied in meeting the curricula requirements. Hence, they had no motivation to use Virtual Labs, even though it was free and added technical value to them.

IV. Problem Statement

This paper hypothesizes that motivation of students will improve and sustain when they perform a minimum number of experiments and get adequately conversant with the interface and experiments. In addition, by simultaneously addressing their self-actualization need through a suitable process of recognition, the usage would increase substantially. This paper presents the approach adopted by Virtual Labs, IIIT Hyderabad team, to enhance the motivation of the students to use the virtual labs and validate the hypothesis. The measures for improvement of motivation are enhanced usage, usage per student and per college. The results were derived from workshops conducted after 2018, in 29 colleges on over 5000 students. Most of the colleges in the sample were Tier 2 colleges that do not have adequate infrastructure.

V. Approach and Interventions

The approach to enhance motivation of the students is based on the following key observations made during workshops done prior to this effort.

1) Students were not familiar with the contents of Virtual Labs, navigation and portal features despite the initial demonstration given by outreach field engineers. Many students gave up after some initial try.
2) There was resistance to spend time even to browse the portal, wherever there was an initial difficulty.
3) There was no compelling reason for the students to adopt Virtual Labs, as they were busy with their regular curricula.
4) There was resistance, both in the faculty and the students to accept a new initiative, except for 5-8% early adopters [5]. Most of the larger usage was from interested students or faculty.
5) There was a need to create extrinsic motivation by way of inclusion of Virtual Labs in the curricula or provide temporary reasons that create this motivation.
6) Tier 1 colleges were not enthused by the Virtual Labs as they felt that they already were aware and the experiments available in the portal were not relevant to their curriculum. Students from Tier 2 colleges expected labs to be more relevant to their curricula and Tier 3 colleges did not have any understanding on the importance.

Among the above observations, points 1, 2 and 5 were potential interventions that could be addressed. A analysis of the usage data by the field engineers suggested that the following actions could improve the motivation levels and consequently, the Usage. Motivation theory [6] [7] implies that any direct benefit and recognition or rewards enhances motivation by enhancing the self actualization of the students. The interventions discussed in the subsequent sections are designed to cover these three observations -

- The focus of the workshop activity, after the demos by the field engineers was to navigate through the portal and identify 10-15 experiments that are relevant to the student - subject wise, class wise and lab experiments. From the identified experiments, students conduct 5 experiments in a detailed way. Students select 10-15 experiments from personal observation while conducting workshops, wherein, students appeared to exhibit steady

motivation. Conducting 10-15 experiments simultaneously in 1.5 hours makes them familiar and conversant with the portal. They select any experiment that they want and be aware of the structure of experiments. They will gain comfort in accessing the various sections, feeding data or information as needed and be able to complete the experiment quickly.

- Appeal to the self-actualization [7] need of every student by announcing in the class the names of who completed first, second and so on. Student who completed the maximum number of experiments were given badges and certificates as recognition.
  From a researcher's perspective, the incentives such as mentioned in point 'B', are known to impact motivation to do more experiments - this behaviour was a steady state condition. The whole research was to understand what level of extrinsic intervention would realize a stable motivation to improve the usage of Virtual Labs. The arousal theory was then applied on the behaviour in various workshops, and analysis of data so collected pointed to the possibility that the arousal and choice phases would take impact and stabilize to be a positive motivation by doing 8-12 experiments at a minimum. These steps triggered 'Arousal' and 'Choice' parts of student motivation [8], [9], [10]. Motivation transitions from the initial stage to a steady state. Understanding this transition and where it stabilizes, is the research and novelty in the paper.
  - The first part focuses at arousal that deals with the drive or energy behind individual action. Drive or energy is explained as the purpose that activate individuals' behaviour.
  - The second part referring to the choice people make and the direction their behaviour takes.
  - The last part deals with maintaining behaviour [11]

VI. Implementation of the Approach

The (A) and (B) described in the previous section were implemented iterative in the workshops. After implementing them in 8 colleges, the results showed improved motivation, usages and participation. Students adhered to the instruction given as in point (A) and conducted a minimum of 15 experiments. This created extrinsic motivation but also acted as a way to become familiar with the lab features. This in turn created an intrinsic motivation among a larger number of students. The authors' observation was that those who conducted about 10 experiments developed interest and continued to perform beyond even though the asked number was 15. This served as a way to 'Arouse' and 'Energize' the motivation [8], [9], [10], [11]. The students were also motivated by verbal announcements / recognition of the 1st student to complete and the maximum number of experiments performed. Simultaneously, the students were asked to tabulate their motivation on a scale of 0-10 at various stages of the completion of doing experiments these were self- assessments. They were given a way to assess their level of motivation by saying that a level of 10 is akin to how they feel when they have to leave an interesting movie to come on their own to conduct Virtual Labs experiments. Again, if they state that they would like to sleep rather than conduct Virtual Labs experiments, their motivation level was 0.

TABLE I
Motivation Level Changes

Increase in Motivation as more experiments are done				
User Group	**Start**	**After 5**	**After 10**	**After 15**
1	5.2	5.8	6.7	7.3
2	5.1	6.5	7.6	8.5
3	4.9	6.4	7.5	8.5
4	6.3	7.1	7.8	8.9
5	5.6	6.7	7.7	8.4
6	5.3	6.5	7.3	8.3
7	5.2	6.5	7.3	8.3
8	5.5	6.6	7.4	7.5
Average	5.39	6.51	7.41	8.21
STD	6.51	0.36	0.34	0.54
CV	7.41	5.53	4.59	6.56

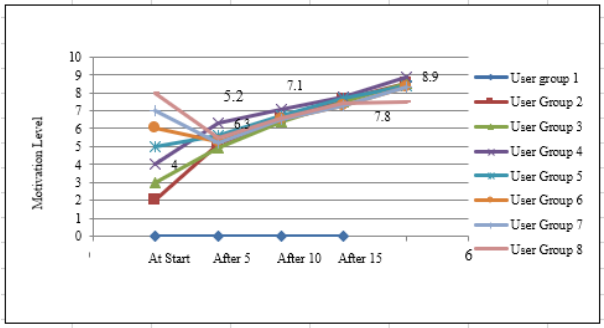

Fig. 2. Motivation of User Groups (Tier 2 Colleges) as different number of experiments were conducted. The bundling of the various graph lines for each User groups is due to the similar behaviour of these populations in terms of the motivation increase.

VII. Results and Feedback Analysis

The results presented herein help us to validate the impact of interventions done to increase the usage, make them competent to use and navigate on the portal and to enhance their motivation to use the Virtual Labs.

A. Increase in Motivation of the students

The self-assessed motivation levels recorded in the feedback form showed a continuous improvement as they performed more experiments on their own, the consistency in the feedback of Tier 2 colleges confirm the transparency. The table I shows the feedback of students from 8 Tier 2 colleges on students' motivation when they conducted the experiments. The data states the actual trace of average self-reported motivation levels of the participating college students at various stages of working with experiments. The Figure 2 presents the same data in a graphical form. The bundling of the graph lines is on account of the similar

TABLE II
USAGE BEFORE AND AFTER INTERVENTION

Usage per student before after Interventions		
User Range	**# Colleges Before Intervention**	**# Colleges After Intervention**
<0	0	0
0-4.9	3	0
5-9.9	7	0
10-14.9	5	2
15-19.9	2	3
20-24.9	0	3
25-29.9	0	1
30-34.9	0	0

behaviour exhibited by student groups in colleges is a clear validation of the motivation created by the interventions at (A) and (B) on 'Approach and Interventions'. From Figure 2, we observe that 2-3 hours duration of the workshops appears to be some internalization of Virtual Labs that has consistently influenced the students' motivation to do the experiments. The 'Arousal' of motivation has also happened to an extent that the average usage per student crossed the expected 15 experiments and reached 19.71 experiments. This was done according to the 'Choice' phase described in (B).

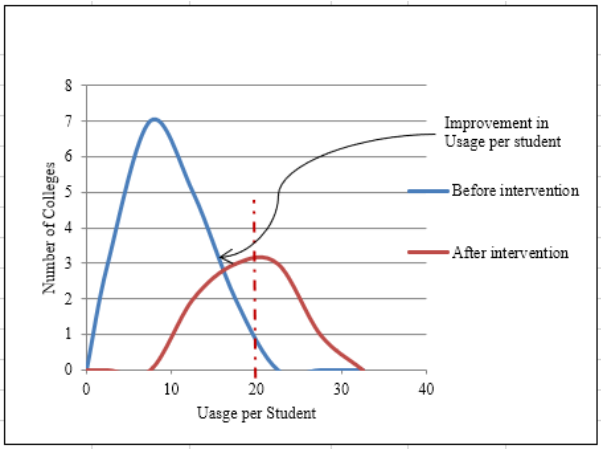

Fig. 3. Usage per student before and after interventions done

B. Increase in Usage per Student

The larger purpose of implementing the interventions stated above is to achieve increased usage of Virtual Labs. The absolute usages improved only when the usage given by individual students has improved. Hence, the authors have focused on 'Usages per student' metric and sought to trace improvements to it. The Figure 3 and table II shows the 'Usage per student' achieved in different Tier 2 colleges before and after interventions, there is an exponential increase in the usage per student after the intervention. The average usage per student has increased from 8.62 to 19.71. The coefficient of variation has reduced from 51.9% to 21.39% signifying that the process is more consistent.

VIII. CONCLUSION

The authors' sought to improve the usage and increase the number of experiments worked on, during workshops in Tier 2 engineering colleges. Specific interventions were made in the workshop processes to improve motivation and thereby the usages per student. Incentives that enhanced their self-actualization such as the announcement of good performers and certificates of appreciation were implemented as part of the process.

As a result, we observed that on an average, students performed more experiments than they were asked, the 'Usage per student' increased from an average of 8.62 to 19.7. They were encouraged to self-report their motivation at various stages of conducting experiments showed a steady improvement at each stage. The average motivation which was 5.39 at start improved to 8.31 at the end of conducting 15 experiments. These resulted in the usage per student going up and the variation in the results being almost halved. Both (A and B) initiatives are now integrated into the process and are being used as a normal workshop process.

IX. FUTURE DIRECTIONS

This paper has focused on the motivation as the key parameter to be improved to get increased usage and acceptance of the Virtual Labs. As a future scope item, an immediate area that could enhance usage and interest of students is to ensure that the courses they study, and the experiments conducted are in coordination with their faculty. Factors such as the improvement of experiment quality and making them user friendly, the inclusion of the virtual experiments as part of the curriculum, development of new experiments that are aligned to the curriculum of different universities and colleges are some of the other areas of research and improvements for increased usage.

REFERENCES

[1] "AICTE Institutes for Academic Year 2019-20 - Engineering and Technology - UG," Accessed on Oct-8-2019, extracted from the official website of All India Council for Technical Education AICTE, Government of India.

[2] (Accessed on Oct-8-2019) Virtual Labs. Available at https://vlab.co.in/.

[3] "Business Dictionary," Accessed on Oct-8-2019, available at https://tinyurl.com/VLabMotivation.

[4] (Accessed on Oct-8-2019) Virtual Labs Outreach. Available at https://tinyurl.com/y2k89d5w.

[5] G. Moore, *Crossing the Chasm*. Capstone Oxford, 1999.

[6] "Self Determination Theory," Accessed on Oct-8-2019, available at https://selfdeterminationtheory.org/theory/.

[7] Huitt, *Maslow's Hierarchy of Needs*. Educational Psychology Interactive. Valdosta, GA: Valdosta State University, Retrieved 2007.

[8] T. R. Mitchell, "Motivation: New Directions for Theory, Research, and Practice," *Academy of Management Review*, vol. 7, no. 1, pp. 80–88, 1982.

[9] L. Abeysekera and P. Dawson, "Motivation and Cognitive Load in the Flipped Classroom: Definition, Rationale and a Call for Research," *Higher Education Research & Development*, vol. 34, no. 1, pp. 1–14, 2015.

[10] P. Shrestha, "Arousal Theory of Motivation," 2007, available at https://www.psychestudy.com/general/motivation-emotion/arousal-theory-motivation.

[11] J. Greenberg, R. A. Baron, and R. A. Grover, "Behavior in Organizations: Understanding and Managing the Human side of Work," 1993.