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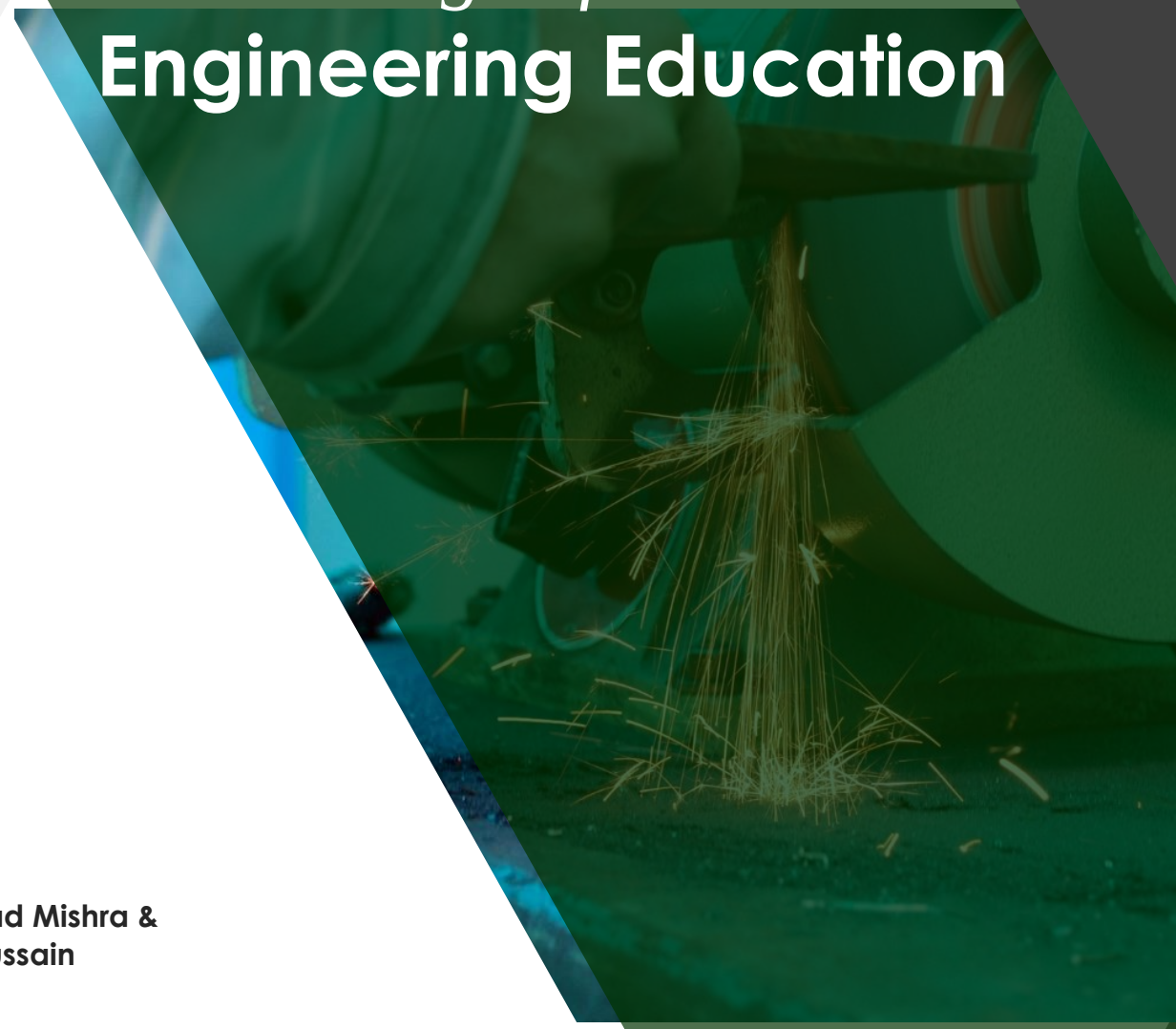

Editors
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PREFACE

NITTTR Kolkata has been conducting a series of webinars and conferences in the last few years. National Conference in Engineering Education (NCEE) was a small endeavour to call upon the researchers from academia and industry to discuss recent trends in Engineering Education. Engineering Education is facing a lot of changes and challenges in the present time, and more so, in a country like India. This has affected both the academic institutions and the world of work not only in the nation but also across the globe. Hence, the primary focus of NCEE was to rethink Engineering Education in a broader and effective manner.

The aim of this conference was to bring together researchers, academicians, policy makers, industrialists and other stakeholders to a common platform so that different strategies to improve the overall technical education of the country could be explored. There had been papers from different parts of India.

Papers were presented mainly under the following tracks:

- Online pedagogy
- Women in engineering education
- Blended learning
- Impact of globalisation& privatisation
- New teaching technologies
- Artificial intelligence in Engineering Education
- Outcome based education
- Prospects & Challenges in Engineering Education
- Learning Analytics
- Educational datamining

The enclosed papers are the ones which were accepted and presented in the conference. All the papers have undergone blind reviews. We are thankful to the reviewers namely**,** Prof. Urmila Kar & Prof. Sukanta Kumar Naskar, from the Dept. of Education & Management, Prof Sagarika Pal, from the Dept. of Electrical Engineering, Prof. R. Subbarao & Prof. Subrata Mondal, from the Dept. of Mechanical Engineering, Prof. Indrajit Saha, from the Dept. of Computer Science & Engineering, who have taken pain to review the articles.

This compilation is for everyone who is interested in the advancement of Engineering Education in the country. We take this opportunity to congratulate the authors and the entire team of NCEE. Looking forward to having many more academic interactions in the coming days.

Debi Prasad Mishra
Director, NITTTR Kolkata
Conference Chairman

Habiba Hussain
Conference Coordinator

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1 Online pedagogy during the pandemic: An overview on its challenges and prospects

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Abstract

The Covid-19 pandemic has created a big stir in the already existing education system. As compared with the sudden rapid growth of online education opportunities, the implementation of technology in online pedagogy is yet to emerge in a more sophisticated way. The present online teaching is found to be different from the already existing one as the latter is strategically well-planned while the former is hastily introduced and initiated as an urgent need of the hour. One of the most highlighted benefits of online learning is its flexibility; be it with regard to time or place or pace. That is, each and every learner can learn everything they want to, at their convenience. Student expectations for high quality any time and any place education demand novel approaches to teaching and learning. The use of technology in online teaching plays a very important role in which the teachers administer the best possible pedagogy. The digital revolution due to the pandemic has indeed changed the way we learn. It is perhaps a new facet of future education system. In this paper, the challenges as well as the prospects of online pedagogy due to the Covid-19 pandemic have been thoroughly discussed. Major concerns affecting teachers and students have been identified and their solutions have also been highlighted. This paper also explores the future opportunities of online pedagogy.

Keywords: Covid-19 pandemic, Online pedagogy, Online education, Technology in online teaching.

Introduction

Online pedagogy can be simply defined as an activity of educating or imparting knowledge via online using different digital media platforms. The concept of distance learning dates way back to the late 1800s at the University of Chicago where the first correspondence program was established [1, 2]. This paper explores the evolution of distance learning from an optional mode of education to a mandatory one with the advent of Covid-19 pandemic. Surprisingly, the ongoing pandemic has resulted in manifesting a wide range of audience to distance/online learning. As the matter is urgent, schools and universities worldwide are, therefore, gearing up to use and implement different software applications and platforms facilitating the online learning.

Schools and universities across the globe focused on online teaching and learning in March-April 2020 in response to restrictions due to Covid-19 [3, 4]. Since the beginning of the pandemic, academicians have been seriously concerned about its impact on the effective delivery of courses to students and are constantly investigating the use of technology for the stated purpose [5]. The introduction of technologies into the teaching-learning process

has significant consequences on pedagogical outlook as well as on content development [6]. The content development, therefore, needs to have a paradigm shift, having a few important criteria; viz. it should be self-explanatory, objective-oriented and concise. Since students were not accustomed to such type of online pedagogy, unfortunately, they become prone to develop negative attitude towards it. A student-centric educational method, therefore, needs to be inculcated in the new pedagogical approach, wherein more and more responsibilities and tasks are assigned to them and they feel a sense of involvement in the overall development of the new system of learning resulted due to the pandemic.

Educational institutions have, in fact, gone through a sea change during this pandemic period. They are now implementing different suitable methods and activities in view of the requirements and expectations of the students [7]. A Learning Management System, that were created in order to monitor and evaluate students, aids teachers in managing their lectures and courses [8, 9]. At present, Spoken Tutorial is an initiative of National Mission on Education through ICT (Information and Communication Technology), Ministry of Education, Government of India, to promote IT (Information Technology) literacy through open source software. Spoken Tutorial Forum is a friendly online discussion forum. Anybody can join the existing discussions or start new topics and receive responses from the Spoken Tutorial community. Registration to the forum is completely free and takes only a minute.

According to Levine and Sun [10], "Distance learning remains immature and experimental. Higher education institutions need to innovate and allow distance learning to evolve and develop, but they cannot do so wholly unchecked." Furthermore, Drago and Warner [11] declared that "Online education is here to stay, but if quality education is expected through this mode of delivery, its relationship to various learning styles should be investigated." Willis [12] believes that, "When memory and retention brain research are applied to the classroom, they not only drive the learning process, but also allow educators to energise and enliven the minds of students."

One more important point to be mentioned here is the three types of presence associated with the online pedagogy [13]. The first is the social presence that aids in open communication and group cohesion. Second, cognitive presence is the cyclical process of inquiry that begins with the right way of questioning, from which follows exchange of information and ideas, new ways of learning, and eventually testing of these concepts in new environment, which in turn may create another cycle of inquiry. Teaching presence is the third and very essential element of a quality learning experience. It provides the foundation for the social presence as well as the cognitive presence through course curriculum and its design, supervision and facilitation [14].

Challenges of online pedagogy due to Covid-19 pandemic

Online teaching comes with some kind of challenges too, the most common one being the technical issues. Lack of technical skills at teachers' end are also paramount. It has been observed that the teaching styles of many teachers have not been able to adapt well with the online mode. The emergent introduction of online pedagogy due to the pandemic has actually created a stir among many senior teachers. The reasons are many; some are not equipped with the latest online technology, some are slow in adapting with the new online platforms, some find it not-so-comfortable with the camera as well as with audio adjustments. All these may sound silly for many young academicians but the problems and challenges faced by a significant number of teachers cannot be ruled out. The Covid-19 pandemic has actually shocked not only teachers but also students, who were unfamiliar with online learning platforms and suddenly becoming an obligation overnight; a drastic change from traditional learning to exclusive online learning in a very short time. Lack of physical presence of classmates have actually led to isolation and inability to have a healthy social bond among them. They feel less motivated most of the times as the teachers are not present during their need of discussion. Assimilation of vital information provided by the teachers in online classes have been found to reduce significantly in many of the average students [15]. It is

extremely necessary to understand and investigate the development of online education in terms of quality and contentment. It has come to light that the disparity between students in higher-income and lower-income households exists [16]. Accessibility of computers and high-speed internet services are still a far cry for many students of low-income households. Also, availability of internet is a major issue in several remote places.

The constant exposure and engagement in online mode have initiated some kind of problems for many senior/aged teachers. Health issues, with regard to this new and rapid implementation of online delivery mode, are in the rise. Major concerns impacting students due to online learning have been identified; viz. lack of social skills, short temperament, reduced physical activities, etc. While some subjects are fine using the online mode, several others are best learnt in person, especially the laboratory experiments. The distractions around the students while in online classes cannot be ruled out. Such setbacks actually reduce their motivation. One of the main challenges of teaching online is sustaining the laboratory components of classes. Since many laboratories require specific equipment, it becomes difficult to reproduce them beyond that physical space. The laboratory courses are indeed much affected during this ongoing pandemic. Many teachers, however, have tried their best to work on the problems and challenges by introducing software simulation as well as setting up laboratory platforms virtually.

One more challenge of teaching in virtual mode is the number of excuses given by students for missing out classes. This irregularity may not sound as a major issue for some, but many teachers tend to become lackadaisical due to such casual approach on the part of students. Also, it becomes difficult to take care of each one of the students if the class attendees are in large number because there is time factor involved. The more the number of students, the more haphazardness it becomes! Even if one argues that it is immaterial of the number of attendees, the fact is that the quality of learning is a little bit compromised.

Prospects of online teaching-learning mode in the pandemic period

With such an unsure future due to the pandemic, the online teaching-learning mode seems to stay here for quite sometime. As they say, there is always an opportunity in every adversity; the present challenging times seem to have actually helped in reshaping and moulding the existing education model in a more efficient one and is becoming less daunting. Perhaps the future may likely have a new education model wherein both online as well as offline modes of learning become a necessity. Methodical and the right use of technology are also needed. As an example, free application google forms for conducting quizzes are indeed time saving. Thus, the assessment can also be done instantly. The basic advantages of online learning include anytime and anywhere access to learning, cost reductions, ability to reach out to larger audience, more effective learning with suitable instructions, and flexibility.

Online pedagogy is still in its growing phase. It has a tremendous potential for several developing countries. However, huge amount of financial and human resources is required for its success and effectiveness. A correct amalgamation of synchronous and asynchronous learning can be implemented based on his or her own pedagogy and teaching style. Success of online classes also depends on the same commitment we all bring to the regular traditional classroom teaching-learning ambience. If the same decorum is maintained in the online classes too, then there will be no question of quality compromise. It is advisable to join online classes in a quiet place whenever possible, to turn on the video whenever needed and to unmute the device microphone only when if it is required. In other words, use of technology in a controlled and proper manner helps in its successful outcome.

Online learning has provided opportunities favourable to the lifestyles of increasing numbers of non-traditional students. In the present society, where people often change their jobs as well as where raising families single handedly are not uncommon, online teaching-learning process has emerged as an essential and pragmatic alternative [17]. Academic achievement increases manifold when the instructional delivery and assignment

tasks are in congruence with the learning styles of the students [18].

The tasks of teachers have increased manifold with the advent of online education system. In online teaching, it is even more important than in the traditional classroom teaching to have a well-developed case study or problems prepared in advance. A dedicated teacher usually prepares a detailed agenda and learning outcomes before each session and advocate students to spend some time on collaborative work or group discussions. The transition between different activities or topics of discussion should be well-defined and explicit. It often helps teachers in good execution of their lectures if they practice the presentation beforehand. The more they practice, the better is the overall outcome of the class. Technology is such a tool that the more one practices, the more equipped one becomes and the skill never goes in vain. Hence, if a teacher is truly dedicated and sincere about his/her responsibilities, especially post Covid-19, then it is quite sure that he/she will make necessary shifts in the face-to-face teaching practices to make the most of online learning [19]. In online teaching, it becomes necessary to simplify and slow down the contents because it is not conducive to cover a large amount of the course, rather focus should be on the more essential parts of the course and engaging students to do most of the activities. So, teachers should keep in mind what actually holds leverage to the students. Summative assessment should focus on creativity.

Conclusion

The digital revolution due to the pandemic is dramatically changing the way we learn. It is not just flipping the regular or traditional classroom content online. Rather it is more of a dawn of a completely new dimension in the education system. The technology provides a very vital mechanism through which the teachers implement the best possible pedagogy. Such an online pedagogy will be effective only when it accentuates student-centric learning. In online teaching, video may or may not be compulsory but audio is a must and therefore, emphasis should be given on pitch, pace and necessary pause. Lack of inflection is a complete no-no.

Formative assessment tasks as well as meaningful discussion forums can be created for the students, such that they are bound to have active learning during the entire process [20]. They can be provided with both synchronous as well as asynchronous methods of teaching, whichever is suitable for the concerned topic or course. They can submit their assignments, presentations, feedback, etc. in a particular platform so that everybody in the class can open up without any hesitation and participate in the discussions. The assessment, review and grading can also be kept transparent in such digital platforms.

One of the greatest challenges teachers have faced during online teaching is the "connection" with the students. It is as if they are there, yet they are actually not. In other words, creating a productive learning ambience by engaging all the students becomes a herculean task at times [21].

Prior to introducing online pedagogy to the students, teachers are supposed to have plausible answers for the following two important questions:

1. What are the challenges of teaching in an online mode?
2. What strategies do the teachers or instructors employ while teaching online, so that the students are thoroughly engaged and the quality of their learning is not compromised?

The answers to the above questions are very important, because it has been observed that students who take active participation in collaborative learning and interact frequently with their teachers score good marks and pass with high grades. They become much more satisfied with their education, even though the entire online process has been not-so-easy task in its initial days.

Building online community is also necessary. A conscious effort is needed to create spaces for sharing online. Group work is another strategy that the instructors manoeuvre to actively involve students in their own learning. Most instructors use detailed rubrics for quality and quantity of participation online, which they use to provide feedback and also to grade each discussion or activity. The course must be

structured to balance the goal of learners and their responsibilities.

Now, after all this discussion regarding the challenges and prospects of online pedagogy, it should be noted that not everything in online teaching is different from the traditional face-to-face teaching. Some aspects of good teaching definitely remain the same; viz. clear, concise, concrete, complete, correct, courteous and coherent communication from both ends. After all, good teaching is good teaching and it seldom matters whether it is offline or online, even though it just might look a bit different in the virtual mode. In fact, focus should be on genuine learning, wherein students should be vocal about their doubts and quests and have options to present assignments as well as presentations in various creative ways.

Acknowledgement

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2 A Study on Gender Equality Gap in the Field of Engineering Education in India

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Abstract

Gender equality is a human right, and it is very much essential to ensure sustainable development and maintenance of peace around the world. This paper focuses on the comparative analysis of involvement of men and women in the field of Engineering, in India. The data obtained along with graphical representation in this regard clearly shows that inspite of gender equality there is a huge gap, yet to be bridged. Here it is clearly depicted that in the field of Engineering Education, the scenario is depriving. Although in the education field women students are welcomed and the average ratio is approximately 30%, but, in work front the statistics show only 25% of women are employed in private sector and only 16% of women are employed in public sector, which is yet a challenging situation for women engineering students. In fact, the paper also highlights the dominance of men, in certain field of engineering, were the entrance of women is less than 10%. The observations and analysis are based on government statistical data, that clearly shows us the status of women in society at present and also in the last 10 years.

Keywords: Gender equality, Women students, Engineering education, Women employment

Introduction

Greater gender equality in engineering education is crucial and is essential for larger interest of technological progress in the society. Currently, India is going through a situation where women are studying Engineering but there are not as many women in Engineering careers. Biasness in gender participation in technology is similar globally. Previously when the modern engineering education and profession were developed and institutionalised, women were excluded from participation [2]. India is also one of them. But presently India has improved its condition. The latest All-India Survey on Higher Education (AISHE) report suggests that the gender gap in India has been narrowed in comparison with the past few years. According to the statistics engineering women, undergraduates in 2018 were over 31% compared to men. But it is observed that since 2010 the proportion of women undergoing engineering field has very slow risen occasionally [4]. Though the scenario for entrance in engineering education has been changed for women but the scenario is still depriving in work front. Despite the gains in gender equality, ambivalence still surrounds `the woman engineer' till today [3], which

means there is still a gender gap in Engineering [7].

India is one of the highest in number of women in professional courses but still they face a number of challenges and obstacles in this field of engineering. Moreover, there is a cultural contradiction, as India worships women as pure and symbol of love and care, so between being a woman and then being an engineer is really a challenge [5], it is difficult as women are depicted as `soft' while technology is described as `hard'.

Society depicts that men and masculinity are connected to power and prestige. From the beginning women and femininity are excluded or restricted from fully taking part in activities of social, behavioural patterns of life [4].

It is not only in the society, it is among students, also, their perceptions of science show that more women than men say that science is difficult to understand, whereas more men say that science is destructive and dangerous, so it is more suitable for boys. [8] Less number of women in engineering may also be due to the fact that women are empathetic in their personal values and beliefs, whereas engineering is not. Hence there can be reformulation of the engineering education so that empathetic values can be included as vital components to the existing curriculum. [10] So that women can be encouraged in the field of engineering. The interpretation of gender patterns in engineering, follows an ambiguity in female engineers' position because the woman's place in the society is of a moral guardian and used as an appealing enjoyment to the pragmatic hard working man. [6]

The relationship between pursuing higher education and their uses in creating political, economic, and social success, identifies ways for women and men to shape their lives. [9] So, women are restricted to certain branch of engineering such as Computer, Food, Planning. In contrast Mining, Marine and Mechanical engineering has traditionally been a leading branch of industry and is invariably dominated by men. The irony is that the Engineer's day is celebrated on 15th September and International Women in Engineering Day on 23rd June. There is no such International Men in Engineering Day, as men are thought to have the right to be engineers but women don't so they celebrate their day as achievements as engineers.

In the present study, analysis have been done with real statistical data, which deal with the fact that women are deprived in the engineering field. The paper unveils the real scenario of the society, where engineering education is a real crisis in India. Last 10 years' data reveal that the condition of women engineering students in India is same. The study has been done on three different levels that is of Diploma, Under Graduate and Post Graduate students. In fact, the paper also marks the dominance of men in certain branch of engineering.

Methodology

In the present work gender equality gap in the field of engineering education in India has been studied. The study has been conducted using the following steps.

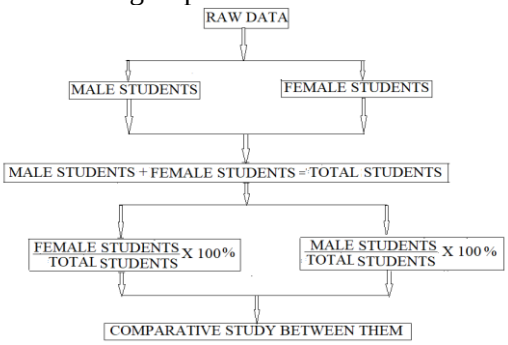

Fig. 1. *Flow chart to obtain the percentage of students in Diploma, Undergraduate and Postgraduate in Engineering and Technology in last 10 years*

Firstly, the raw data of last 10 years have been collected from the Ministry of Statistics and Programme Implementation, Government of India. The raw data obtained is the ratio of number of female's involvement for 100 males in engineering field. The ratio of female students (F) and the ratio of male students (M) are added up to find the total ratio of students (F+M). Then these data are converted to percentage form which has been depicted through a common flow chart as given in Fig No. 1. At last a comparative study has been done.

Secondly, the number of male and female students in Diploma, Undergraduate and

Postgraduate degrees in the last 10 years have been collected from All India Council of Technical Education, Government of India. The data obtained are the number of female students and male students in different degrees. The number of female student and male students are added up to find the total number of students. Then these data are converted to percentage form which are depicted in the common flow chart Fig No. 1. Then the data is processed for further comparative study.

Thirdly, the raw data that is the number of male, female and total number of students in different engineering field, have been collected from the Ministry of Statistics and Programme Implementation, Government of India. These data are converted to percentage form which is shown in the flow chart Fig No.1. The data is then processed for comparative analysis.

Results and Discussion

Percentage of Male and Female Students in University Education in Engineering and Technology in last 10 years [1]

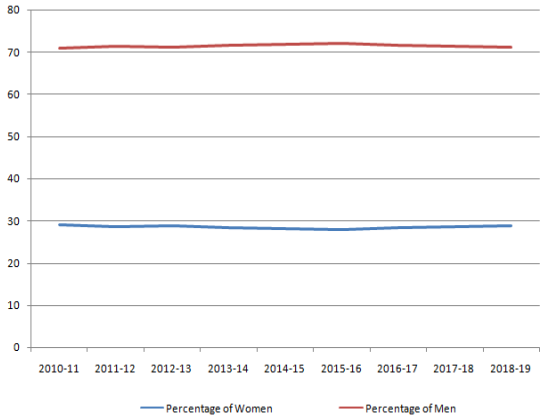

Fig. 2. *Graphical representation of percentage of students in Technical Education in last 10 years*

Fig No.2 gives us the graphical representation of the Male and Female students in Technical Universities in last 10 years. The scenario is static. The gap shows us that there is a long way to go, for women. Moreover, only 40 % of women for 100% of men are privileged to be a part of the technology. In fact, the resistance is so high that out of 700 students only 200 students are women and 500 students are men. The ratio is very depriving i.e 30% women to 70% men. 40% gap is yet to be bridged.

Percentage of Male and Female Students in Diploma, Undergraduate and Postgraduate in Engineering and Technology in last 10 years [13]

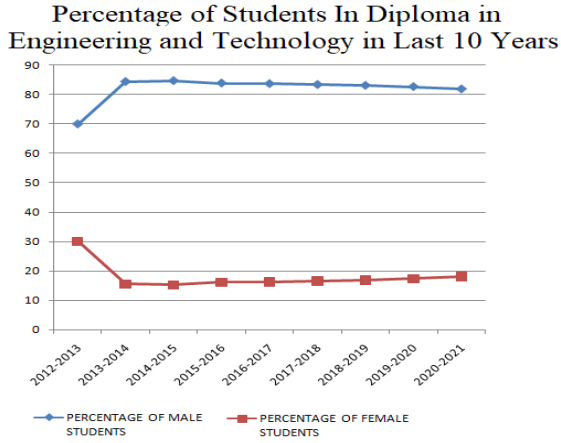

Fig. 3. *Graphical representation of percentage of students in Diploma in Engineering and Technology in last 10 years*

Fig No.3 gives us the graphical representation of the Male and Female students in Diploma in Engineering and Technology in last 10 years. In 2012-2013 the scenario is different where the ratio of male student to female student is 7:3; whereas from 2013 to 2021, the representation is very depriving as 80-85% male student are enrolled in contrast to 15-20% female students. There is 60% gender gap in Diploma.

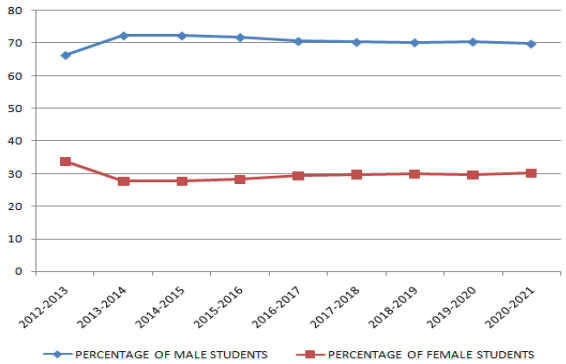

Fig. 4. *Graphical representation of percentage of students in Undergraduate in Engineering and Technology in last 10 years*

Fig No.4 gives us the graphical representation of the Male and Female students in undergraduate in Engineering and Technology in the last 10 years. The gender gap scenario in undergraduate students is better than the Diploma students. As 65-75% male students

are enrolled in contrast to 25-35% female students. Still the gender gap is 40%, which is again not healthy for society.

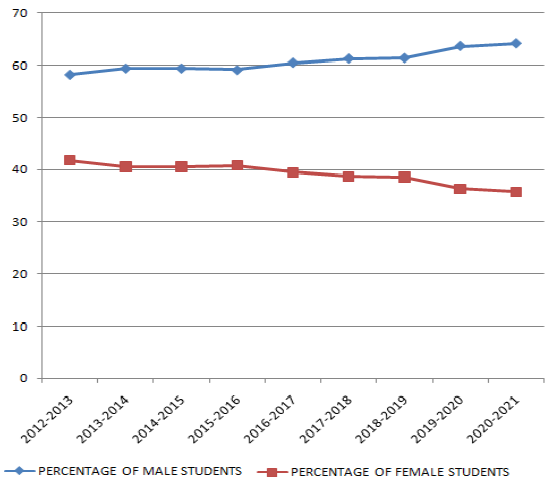

Fig. 5. *Graphical representation of percentage of students in Postgraduate in Engineering and Technology in last 10 years*

Fig No.5 gives us the graphical representation of the Male and Female students in postgraduate in Engineering and Technology in the last 10 years. The scenario here is even better than the undergraduate students as 55-65% male student are enrolled in contrast to 35-45% female students. Still there is 20% gender gap. But the condition is much better than the condition in Diploma and undergraduate. But the alarming condition is that the graph is diverging i.e. the gender gap is rising.

Comparative study of Male and Female students in different branch of Engineering and Technology [1]

Fig No.6 gives us the graphical representation of Male and Female students in different fields of Engineering. The scenario is depriving. The graph showcases male and female student contribution of sixteen main departments and some miscellaneous departments. The gap is above 85% in the field of Mining, Mechanical and Marine. So the graph is broadened in this area. Civil, Aeronautical, Metallurgical, Chemical and Electrical shows about 45% gap to be bridged. Dairy and Agriculture have 30% gap. Computer, Food, Information, Electronics and Planning has 5% gap. So the graph is converging in this area. The graph intersects at the point Architecture, where women have taken a lead. Other miscellaneous departments also need improvement as the gap is around 40%.

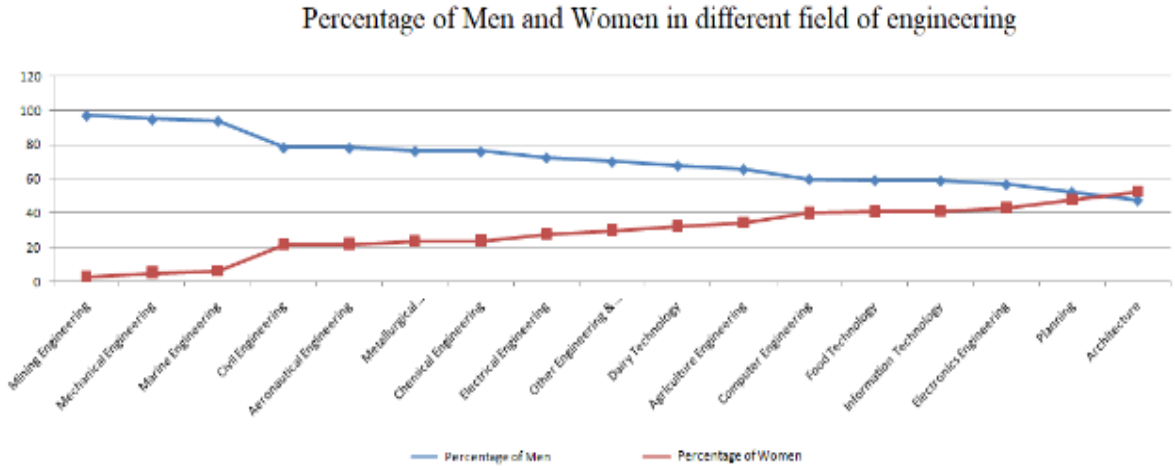

Fig. 6. *Graphical representation of percentage of students in different branch of Engineering*

It is clear that in every field of engineering women are lagging behind. Only in the field of Architecture, women have obtained the position higher than men. In fact, in the field of Mining, Mechanical and Marine women are restricted and so the percentage is below 10%. The deprivation state is so high because these departments are politically and economically powerful and so men have taken the full power in their hands to get prestige. Civil, Aeronautical, Metallurgical, Chemical and Electrical are also the fields were men think that they are superior and so, only they can participate in such hard working jobs and women can't, as they are considered to be soft so, below 30% of women contribute in this field. In Dairy and Agriculture below 35% women contribute. Computer, Food,

Information, Electronics and Planning are the fields where the contribution of women are at par with men as 45-50% women contribute in these fields.

Overview of the Result

The scenario in last 10 years is static. It needs to be improved. Women must be given chance to participate in Engineering. Coming to the different departments, it can be concluded clearly that politically powerful and prestigious departments are held by men in chronological order, this ideology needs to be changed. The thought process of the society that depicts women to be soft and technology to be hard, should be erased altogether. A nation can only improve when its technology improves. Improvement can be done only if both men and women work side by side. By depriving the women and children, no nation can grow. So for the growth of India, the status of women needs to be uplifted. Engineering should become the right for women as it is the right of men.

Remedies

Stereotypical mind-set of the society associated with Engineering and Technology, related to men and women should be changed. The negative opinions related to women from the very beginning needs to be replaced. Specially the comparison needs to be stopped. As both the genders have their own qualities and limitations as per their creation. The thought process in parents and teachers in school, that the abilities of doing math is better in boys than girls, thus underestimating them and limiting their self-confidence, should be treated as an offence.

The old education policy framed in 1986 has been changed. The Government of India has come up with the National Education Policy (NEP) 2020. This policy deals with the challenges for women in education and hence have implemented certain uplifting factors in education [11] and work front. This NEP 2020 have an innovative idea for the upliftment of women students. It introduces the coding part in the education system from grade 6, which means both genders will get an access to technology from a very small age, irrespective of the stereotypical society mindset. The NEP 2020 has also come up with the implementation of equity in higher education, especially for women, [12] that means it will become mandatory for all technical educational institutions to have fairness in the number of women - a big leap for women engineering education.

The Government of India has introduced another Science, Technology and Innovation Policy (STIP) 2020. This policy is promising for the upliftment of women in workforce. This policy deals with the inclusion of women in work front. The STIP 2020 focuses on gender equality and makes it mandatory for governing bodies to include at least 30% of women in all decision-making bodies, in evaluation committees and in scientific selections.

Conclusion

Comparative studies between men and women in the field of engineering have led to the fact that women were previously excluded from participating in Engineering. But in modern times women take part in engineering. Though the scenario is not healthy but there is a ray of hope that the curve is either increasing or static but not decreasing.

Secondly, in the education part, women are allowed to participate but the picture is very depriving in the work front - as mental harassment, workplace adjustment, sexual harassment, insufficient maternity leaves, discrimination at workplace, job insecurity, no safety of working women while traveling, lack of family support and other reasons including age, marital status, level of education etc., already make situation difficult for women to work. That is, even if the woman makes her career in Engineering after so many obstacles still sustaining it, is another mammoth task.

The statistics show that only 30% of women get education as engineers. Hence the society should eradicate their thought process and build up the culture to put forward women as engineers, as women have proved themselves in every field and come up with flying colours; only then we can get female students in the Engineering field.

One important conclusion can be drawn that as we go higher up the ladder in education we see the gender gap is converging. The gender gap is high, down the ladder. In Engineering and

Technology, we have studied three different degrees i.e., Diploma, Under Graduate and Post Graduate. The gender gap ratio is 6:4:2 respectively. Hence we can come to the conclusion that positive thought towards gender equality needs to be instilled in everyone down the ladder than higher up the ladder.

All the findings here are related to Engineering Education only. So in future there is a scope to bring into light, the condition of women in other departments of Education also and the condition of women in public and private workforce. Only then we can completely portray the condition of women in India, in all departments of education and workforce.

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3 Hybrid Learning: Essential Pedagogical Modifications for Effective Teaching-Learning Processes at Tertiary Level

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Abstract

Rapid transformation in education has forced many countries in the world to take steps to reform extensively the aspects of curriculum and teaching- learning processes. Education is one of the sectors which is being subjected to most significant changes due to covid-19. Institutions across the world remain closed and education is being shifted largely to online mode. Changes in pedagogy are required when we switch from traditional education to digital education. According to education experts, a hybrid learning system which comprises face-face learning and synchronous and asynchronous digital learning, is likely to continue in the world, especially in higher education. This paper mainly examines the pedagogical modifications required for tertiary education when it is moved from traditional classroom system to a hybrid system. A comparative analysis of student's perception of face- to-face and online education was also done as part of this work. Effective procedures in digital education, elements that contribute to the new pedagogy of hybrid learning, factors to be considered in the development of pedagogy are also incorporated in the article.

Keywords:
Hybrid learning; Blended learning; Pedagogy; Synchronous; Virtual reality; Augmented reality; Digital learning

Introduction

The transformation in education is aimed at providing students with more quality education to meet the needs of life and work in the 21st century [1]. The curriculum and the 21st century teaching and learning activities should cover all skills needed in the 21st century education [2] and various skills must be mastered by students to ensure that they are able to compete in line with the rapid changes happening in the world. The covid-19 pandemic has significantly disrupted the education sector across the world. Schools and higher education institutions remain closed since March 2020, confining millions of students to home. The structure of schooling and learning, including teaching and assessment methodologies, was the first to be affected by these closures. Even though, the institutions remain closed across the world, the teaching-learning processes are happening to a certain extent via online. Needless to say, the pandemic has transformed the centuries-old,

chalk–talk teaching model to one driven by technology. E-learning brings a variety of benefits that include: (a) reduced costs, for example in traveling expenses, (b) students learn in a place of their own convenience, (c) students define the pace of their learning and (d) institutions increase flexibility in their educational systems [3]. In this time of crisis, an effective educational practice which enhances the hard and soft skills, employability and productivity of youths is required.

Pedagogy is a common terminology in education which comprises mainly two aspects, the way teachers teach, and the way students learn. Because of the changes that took place in the society due to variations in student expectations and advances in technology, even before covid-19 pandemic, there were active discussions on the need of revision in the pedagogical aspect. Social media and technologies such as smartphones and tablets, give the students, much more control over access to and the creation and sharing of knowledge. The switching to online learning fully or partially has now made modifications in pedagogy mandatory. Utilization of learning management systems, open educational resources, computer-based assessment tools, technologies like augmented, virtual and mixed realities require special guidelines and methodology. Implications on stakeholders of higher education need to be considered in the pedagogical changes.

There are different views on, how the education sector is to look like after covid-19. Most of the education experts believe that, a blended/hybrid learning system, which is a mix of face-to-face classroom learning and digital learning is likely to continue. It is thus important to reconsider the current delivery and pedagogical methods in higher education by seamlessly integrating classroom learning with e-learning modes to build a unified learning system. Students' perception on the merits and demerits of face-to-face and online mode need to be ascertained and considered during the framing of the pedagogy for hybrid system of education.

Hybrid Learning

Blended learning refers to the integration of traditional classroom teaching with e-learning activities in order to enrich delivery in the learning environment [4,5]. Blended learning involves putting the major learning activities online while retaining traditional classroom teaching in a way that captures the best of face-to-face classroom teaching and online learning [4]. When the benefits and barriers in blended learning were explored in two US high schools, it was found that both the students and parents accept this kind of learning due to its efficiency [6]. Examination of perceptions on blended learning in higher education led to the finding that blended learning facilitated flexibility in learning times and increased individuals' responsibility for learning [7].

Switching totally from face-to-face learning to pure online learning may not be a true option for future college and university education. Combination of face-to-face class room learning, synchronous and asynchronous online learning seems to be the best way ahead.

Pedagogy of Hybrid Learning

The pedagogy of teachers should extend beyond the current educational needs in order to keep up with the needs and skills of coming future. In order to reach the 21st century pedagogy level, each teacher should have the skills to integrate the information and communication technology (ICT) in the teaching and learning process [8]. To ensure that teachers are able to master the 21st century pedagogy, they must be one step ahead of their students by being more proactive in preparing themselves with ICT knowledge to be creative and innovative teachers [9]. Knowledge of pedagogy and knowledge of subject are both important for effective teaching. Student-centred learning and active learning activities are essential components of online pedagogy. More than the knowledge in technology, an interest in pedagogy is required for a teacher to be successful in online teaching. Some of the teacher competencies are same for face-to-face and online teaching. However, competencies like communication skills, time management skills, knowledge in technology, perfect lesson planning etc. are very important for the success of online teaching.

To be a good candidate for online learning, the student must be committed to learning, have a positive attitude and possess time management

skills. The major issue usually reported with traditional classroom is that it makes the learner passive. In contrast, the online learner will need to take an active role in the learning process. The learner must be self-directed and motivated to succeed in online learning. In online learning, the role of teacher must be to guide, support and encourage the learner and help facilitate in the learning process. Students need to be given more activities, projects and assignments, which they have to do by making use of online resources, peer discussion, society interaction etc. Putting simply, an increased sharing of power should happen between the instructor and the student.

Learning tools for effective digitalisation of education, elements that contribute to the pedagogy of hybrid learning and factors that are to be considered in the development of pedagogy need to be discussed.

Digital Learning Tools

Learning Management System

In the twenty-first century, the use of Learning Management System (LMS) has changed the face of distance education delivery. LMS is a software that is used to deliver courses or training programs for students. LMS helps to manage the courses efficiently and using it, the teachers can give personalized courses to each student. LMS has the potential to widen access, reduce cost and improving the quality of education that will help SSA institutions to meet the growing student population [10,11]. Reports show that there is a continuous increase in the acquisition of LMS by higher education institutions in SSA [12]. Teacher can identify the weakness and strengths of the student and can guide students to concentrate more on their weakest part to improve it. Live chatting is also possible between teachers and students through LMS. Some of the LM systems also provide option for student assessment.

Virtual Reality

Virtual reality (VR) is an artificial digital environment that completely replaces the real world. Special VR headsets are used to immerse users in virtual reality. Virtual Reality can strongly improve the capacity of the human mind to remember the things it learned for a long time.

Several studies have highlighted the impact of virtual environments on students' self-efficacy [13,14]. Virtual learning (VL) was found to be more effective for improving difficult concepts and scientific inquiry self-efficacy [15]. VL in conjunction with physical lab, significantly improved the self-efficacy of students for microbiology experiments [16]. Improvements in students' learning gains, student engagement, self-efficacy, motivation, and achievement were observed after performing experiments in virtual labs [17-20]. VL also helped teachers to improve their understanding and confidence related to teaching science [21].

VR learning content can revolutionize education, making learning immersive and more engaging. Even though, the VR technology can be applied in the teaching of all subjects, it has immense scope and wonderful results in STEM teaching. Numerous free/paid apps are available to assist VR integration in teaching- learning processes.

Augmented Reality

Augmented reality (AR) is the overlay of digital content on the real-world environment. Augmented reality is also successfully used in education. Although all fields of knowledge can potentially take advantage from AR, there are arguments that education will be particularly modified by its introduction [22]. AR can aid learning and make the overall process more interesting and pleasant [23]. In a rapidly changing society as ours where there is a great amount of information available, it is of major importance to know how to locate information and use it efficiently. AR dramatically shifts the location and timing of education and training [24]. Unlike other computer interfaces that draw users away from the real world and onto the screen, AR interfaces enhance the real-world experience [25]. This study also highlights some reasons why AR educational experiences are different: (a) support of seamless interaction between real and virtual environments, (b) use of a tangible interface metaphor for object manipulation, and (c) ability of smooth transition between reality and virtual.

Augmented reality can elevate learning experiences and energize everyday lessons. AR technology provides virtual examples and make classes more interactive thereby helping students to better remember the information they've just learnt.

There are two main ways to bring AR experiences.

(i) Portable devices

AR is the most accessible reality technology, as people can use their smartphones or tablets to run augmented reality applications. AR apps use a phone camera to capture the real world; virtual objects are then overlaid, and users can see them on their smartphone screen. That's how common AR apps work, the best example being Pokemon Go.

(ii) Smart glasses and AR headsets

Another way to create AR experiences is to use special smart glasses or headsets. Unlike VR headsets, these AR glasses and headsets don't immerse users into a fully virtual environment but just add digital objects to the real world. With Glass, for example, digital data is projected right in front of the user's eyes.

Mixed Reality

In mixed reality (MR) or hybrid reality, virtual content is not only overlaid on the real environment, but it can also interact with that environment. So, we can say, the mixed reality is a more immersive and interactive type of augmented reality. In another type of MR, the users can interact with a completely virtual environment overlaid on the real world around them. Different types of devices are required to experience these two forms of mixed reality:
(i) Holographic devices

These headsets have translucent glasses that allow you to perfectly see your surroundings. Virtual experiences are created with the help of holograms.

(ii) Immersive devices

These headsets have non-translucent displays that completely block out the real world (just like VR headsets) and use cameras for tracking. Mixed reality is also applicable in education. MR provides immersive learning experiences and helps students to better understand what they're learning. Mixed reality can be used from school education to medical and engineering training.

Elements that contribute to the development of new pedagogy

Blended learning

Successful blended teaching and learning require a focus on what best may be done on campus, such as face-to-face interaction between students and instructors, and what may best be done online, such as providing flexibility and wide access to resources and experts. A re-thinking of teaching and learning practice would be required here.

Flipped learning

Even though, the concept of flipped learning is a pedagogical approach in discussion since long time, its effective implementation in traditional face-to-face learning was not a success in most of the countries. The most important aspect of this concept is to inform the students in advance regarding the topics to be discussed in the future sessions and also to share the relevant resources prior to the live sessions. The best advantage of flipped learning is the greater involvement of students as they turn up for sessions with some prior knowledge of the topic. As flipping the class is quite easy in digital education, the concept should have a space in the pedagogy of hybrid learning.

Collaborative learning

Social media allows both teachers and students to have communities for sharing experiences and knowledge. Using such groups, the students can discuss theories, concepts and challenges. Teacher is no longer responsible for delivering all the knowledge or even providing all of the sources for learning. However, the teacher has an important role as a guide, a facilitator, and an assessor of the learning. A re-consideration of the roles, authority, and the

way learning is achieved and assessed, is required.

Self-learning

Days are gone when we used only prescribed text books for courses. Open educational resources (OERs) are available for almost all courses. E-texts books and online libraries are also available free of cost. Such resources are critical in enhancing the knowledge of teachers and students. E-resources are accessible via smartphones, tablets, e-readers and other mobile devices. OERs are helpful in reducing the student expenditure on books and facilitates updating of content. More appropriate OERs need to be identified for each course and must be properly positioned in the plan for teaching. Many reputed universities across the world have online education options in various disciplines. Courses are available in conventional disciplines as well as in most advanced areas. Paid as well as free courses of short/long durations are available. Many of these courses are designed in such a way that, students enjoy involving and easily understand the concept. Such factors also need to be considered during the revision of curriculum and pedagogy.

Mobile learning

Mobile learning or M-Learning is the method of learning through personal mobile devices such as smartphones, tablets or even a laptop. The study materials are either downloaded into the device or accessed online. Mobile learning allows flexibility, allowing students to access education anywhere and anytime. Providing content, tests, and other learning resources to students through mobile devices requires a new look at course design.

Online assessment

Different types of tools/platforms are available for student assessment in digital education. Such tools are easy to use and enjoyable for students and teachers. The fascinating features of such tools are fast analysis and instant feedback. It may not be possible to completely do away with the assessment methods practiced in traditional education. However, at least partially the assessment can be done using the online tools. Assessment using online tools and giving feedback to students can be made a continuous process throughout a course. It will help students to focus on areas of weakness before the final assessment. Teachers can also use the analytics to assess the quality and usefulness of learning materials provided and also track the student involvement.

Factors to be considered in the development of pedagogy

Various factors connected to teaching and learning need to be considered in the development of new pedagogy for online/hybrid learning. The important factors that can influence the pedagogy of hybrid learning are:

- Pedagogical knowledge and skills which teachers already have.
- Students need on how they are to be taught and assessed.
- Success rates of online/hybrid learning.
- Strengths and limitations of online delivery in each course.
- Role of students and teachers in hybrid learning.
- Types of technologies and software's available and to be used

Study on student perception of face-to-face and online education

This study examines if the students find online education superior to face-to-face in person education in meeting individual learning needs. It also investigates the effectiveness of peer learning, skill enhancement, easiness in feedback etc. in virtual learning. Analysis of the data collected clearly shows that, virtual education is superior to face-to-face in person education in getting timely feedback and answers. However, in aspects like meeting individual learning needs, peer learning, student-teacher interaction etc, the tertiary level students prefer physical classroom learning over online learning. The study sample consisted of 494 students who pursue either bachelor's degree or master's degree course in various disciplines. Of the total participants, 82% were bachelor's degree and remaining 18% were master's degree students. Even though the research population comprised both male and female students, 75% the total respondents were female students.

Indicator	Agree (%)	Disagree (%)
Online education meets individual learning needs	38	62
Soft skill acquisition is more effective in online mode	30	70
Hard skill acquisition is more effective in online mode	32	68
Easy to get feedback and answers in online mode	51	49
Teacher performance in delivering content is more effective in online mode	62	38
Teacher-student interaction is sufficiently happening in online mode	37	63
Student engagement is more in online mode	30	60

Table 1. *Responses of students regarding online education.*

It is clear from the table that only 38% of the total responders are of the opinion that online education is more effective than face-to-face classroom education in meeting individual learning needs. Presence of students with diverse views, interests, intelligence, learning styles etc. in a class is always a challenge to any educator. When 60% of the students are of the view that virtual education does not meet the individual learning needs, suitable modifications need to be thought of in pedagogical strategies.

As per the data collected, only around 30% of the participants felt that online education is effective in inculcating the required soft and hard skills in students. More than 50% of the participants believe that online education is effective than face-to-face classroom education in giving timely feedback and providing the correct answers. Only 37% of the research population felt that the teacher-student interaction in virtual sessions was satisfactory. When the interaction between students and teachers reduces, normally the teachers will not be able to understand the needs of the students. This can be one of the important reasons for the student perception that online education does not satisfactorily meet their learning needs.

Analysis of student perception on 'student engagement' showed that just 30% of the participants agree that student engagement is satisfactory in online mode.
Observations in these types of investigations also need to be considered in the framing of pedagogy for hybrid learning.

Conclusion

Education is perhaps the most significantly affected sector due to covid-19. The emerging changes invite partial or complete overhauling of curriculum/pedagogy in many of the programs in higher education. Hybrid/blended learning system, which is a mix of face-face and online learning is expected to be the new educational system. Integration of online education to traditional education necessitates modification of pedagogy. Numerous studies have been done on the merits of online learning. Investigations on drawbacks of online learning have also been reported. Enough brainstorming is essential for the development of a full proof pedagogy for hybrid learning. Different elements that contribute to hybrid learning need to be analysed and the possible factors which influence the pedagogy are to be considered. Most suitable platforms and technologies need to be identified for the integration of virtual teaching to the traditional face-face teaching. Some tools are already in use for assessment of learning in digital education. Most appropriate tools from those can be used along with the conventional assessment modes. Student-centred approach is critical in the development of curriculum and pedagogy of hybrid learning.

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4 A comparative study of the challenges and opportunities of the engineering education in the current scenario of COVID pandemic coping up with the skill based objectives

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Abstract

This paper aims to study the different challenges and opportunities in technical education which is currently undergoing a paradigm shift of the pedagogy especially due to the need of skill based industry embedded system. The conventional prevailing system in India imparting technical education is mostly concealed in the walls of the institutes which does not produce job ready candidates for the industries. The students after the completion of 3 years of diploma or 4 years of degree become just clear with the basics to some extent as they do not have much exposure to the industries despite limited industrial/vocational training as a mandatory part of their curriculum. Therefore, to cope up with the requirement of the practical regime, the practice of the basic knowledge is the utmost necessity. The worldwide trend of skill based education, therefore, is an ultimate objective. However, the recent pandemic is the greatest obstacle as the hands on practice in most of the time cannot be achieved on line.

Key words:
STEP, PMKVY, Cognitive skills, Psychomotor Skills, ILO.

Introduction

The cellular phone generations from 1G to 5G took just 40 years to evolve. The Ambassador car (1958-2014) once known as the 'King of Indian roads' has got a superb and surprising makeover and the new DC2 e-Amby fully digital is arriving in 2022. The technology is changing very fast. The digitalization and automation has seen the renaissance. The curriculum and pedagogy implemented to various technical streams and to be produced in the next 3 to 4 years, is found almost obsolete due to the fast changing technology. The gap between the industry and institute is always ever increasing. India is the second most populated country in the world, having working age between15-59. At one point of time there

was merely 50 technical institutions but presently the number has exceeded 10000 [1]. In 2020 the unemployment rate in India was 7.11% as shown by ILO database. The global rate of unemployment was 6.47%. As the rate of unemployment is also ever increasing, the perspective of the technical education has found a niche for entrepreneurial revolution. A record 807,000 new small entrepreneurial firms were established in 1995 in US [2]. It is reported that more than 5 million jobs were found lost in 500 fortune companies since1980. But the concept of entrepreneurship could create 34 million new jobs. Small business enterprises in US account for 51% GDP in private sector.

Discussion

A World Bank study of 2010 on skills has reported about a simple conceptual framework which is, skills toward employment and productivity (STEP) [3]. This has focused on five steps which are interlinked.

- Step-1. Getting children off to the right start
- Step-2. Ensuring that all students learn
- Step-3. Building job-relevant skills
- Step-4. Encouraging entrepreneurship and innovation
- Step-5. Facilitating labour mobility and job matching

From Preschool age up to working age the STEP can be easily implemented as an integrated set of programs across worker's entire life cycle. Thus the STEP will help policymakers, analyst, and researchers to implement skills for the enhancement of the productivity with assured growth. The level of competency depends upon various skills such as:

- Problem-solving skills
- Learning skills
- Communication skills
- Personal skills
- Social skills
- Cognitive skills
- Psychomotor skills
- Affective skills

These are directly required to be developed through schooling. The cognitive skill is to develop the ability to grasp the subject matter of the different subjects which are being taught. The psychomotor skill will help to apply the skills in practice. While the affective skills relate to a person's attitude towards commitment in respect of time and quality etc. The inputs of the system to ensure good result in education should have different building blocks such as teachers, standards, resources and the regulatory body. The role of exercise shall be the choice and voice. The management shall be based upon the principle by heartfelt involvement of all and the administration should never be autocratic.

Socio-cognitive skills coupled with knowledge and information is the major rationale guiding curriculum change in 21st century [4]. The review contributed a few important concepts which needs to be implied for pedagogical practice. These are:

- Ways of thinking- 1. Creativity and innovation 2. Critical thinking, problem solving, and decision making 3. Learning to learn, metacognition
- Ways of Working- Communication and Collaboration
- Tools for Working-Information literacy and ICT literacy
- World of Living- 1. Local and global citizenship 2. Life and career 3. Personal and social responsibilities with awareness of culture and different aspects of competence.

It was remarkably mentioned that the technology serves both as a driver and lever for the transformation. The emphasis has been given for 21st century competences in learning both in schools and at the workplace.

Pradhan Mantri Kaushal Vikash Yojana (PMKVY) was launched in 2015 to promote skills by providing short term free skill training with monetary rewards and certification. Quite huge investments are being made to enhance the employability. But the result observed later was not very satisfactory. However, the impact of PMKVY for improving the productivity of youth in Gwalior was reported as good, supported by the respondents [7].

The State-wise details of candidates enrolled, trained, assessed, certified and reported placed under PMKVY 2016-20, for 10 states as on 11.11.2019, is given in Table 1 below [5] [6]:

S. No.	State/UT	Enrolled	Trained	Assessed	Certified	Placed	PMKVY investment p.a. (Cr.)
1.	Delhi	283188	270952	233246	211968	57514	54.66
2.	Gujarat	245281	224218	191253	175034	37410	N/A
3.	Karnataka	314091	300923	240199	214743	41643	43
4.	Maharashtra	694498	604153	483710	415113	42670	85.77
5.	Rajasthan	611745	588784	471896	438594	124211	33.11
6.	Andhra Pradesh	192458	181657	159809	142925	71416	35.5
7.	Tamil Nadu	416496	402754	350429	316090	107471	68.86
8.	Uttar Pradesh	1074776	1024173	894902	800972	231147	52.26
9.	Telangana	228139	220195	192581	174587	73868	27.53
10.	West Bengal	298133	278340	243008	217194	76399	38

Table 1. Ten states' data collected from Loksabha questions on Govt. of India, Ministry of skill performance [5] and from the scr journal [6]

According to the survey of 2019, the top ranked countries worldwide has best education model as follows:

United States, United Kingdom, Germany, Canada, France, Switzerland, Japan and Australia.

The pioneer countries have something in common. They have introduced learning as a passion. They have been serious since early childhood days. They have been found continuously working in the development of concept, content and the overall design of each topic meticulously. Roskos and Neuman [8] reported that explicit instruction in vocabulary development plays an important role in learning. Instructional technique cannot overlook rereading as rereading does the reinforcement in learning. Another neglected area for many years has been the lack of appropriate attention to syntax which enables to strengthen every comprehension. They also pointed out that children are quite motivated to learn using digital textbooks.

Challenges and Opportunities

The recent covid pandemic since early 2020 has become the greatest challenge as the skill based learning couldn't be achieved to a great extent without any physical meeting. However, this has become a lesson for us to enable to understand that we, due to ignorance have caused so much damage to our environment which has shown us such alarms. The proper knowledge and skill based learning thus can protect us from such endangered dreadful calamities. We, for the sake of industrialization and pseudo modernization damage the ecological balance. Therefore, truthful learning can only teach us how to live better and longer. This way we can easily convert every challenge into an opportunity. To resolve any issues, generally, decisions are being taken without seeking any expert's view and often in haste led by common, powered by political whims and fancies. This needs an immediate measure to curb such fateful mishappenings in the future. We need to live in a meaningful manner decently in a way so that our future generations can be safe and become proud of us being geared with our wisdom.

The disruption caused by corona virus pandemic could not stop our education system from functioning. This has become possible due to various initiatives with digitalization taken by schools, institutes, colleges and universities at large. All have had to shift to on line teaching without any delay. Cisco, WebEx, Zoom, Google Meet and others' licenses are being procured for on line classes. E-books have been in great use. Various virtual meetings and online classes with many online courses are now available. All are more or less now well equipped with IT infrastructure and resources for E-learning environment. Even all on line examinations are being held smoothly and students have been placed through on line tests and interviews. Nevertheless, despite financial challenges nothing is really defeated.

A success case report

Tata power is the major stake holder of the power supply in Delhi. They hire quite a good number of 03-year diploma engineers from the electrical trades every year. There was a constant complaint that they faced huge challenges to train those fresher candidates. Meetings with the management brought the turning point. It was decided that the organization would provide free of cost training to the final year students on every Saturdays throughout the year for the full day with free meals etc. Students were given exposure not only to the various operation and maintenance by the experts of the company but also all necessary and relevant awareness of the safety and precautions, rules and regulations and most importantly the ethics by and large. They were not only trained thoroughly but also became aware about the duties to be performed if found selected. It also gives an opportunity to the company to know the candidates in respect of their attitude, skill and interest which enables the selection easier and appropriate. It has brought a huge success. This has become now a regular practice as they find it very useful. At the end of the diploma, the students are being selected who are found to be very much motivated, confident and committed

Recommendation of a Model

The proposed and recommended one model of 3-tier movement of the class is shown in Fig.1. It depicts that the development of human potential can be achieved in coordination with the experts from the institutes and the industries.

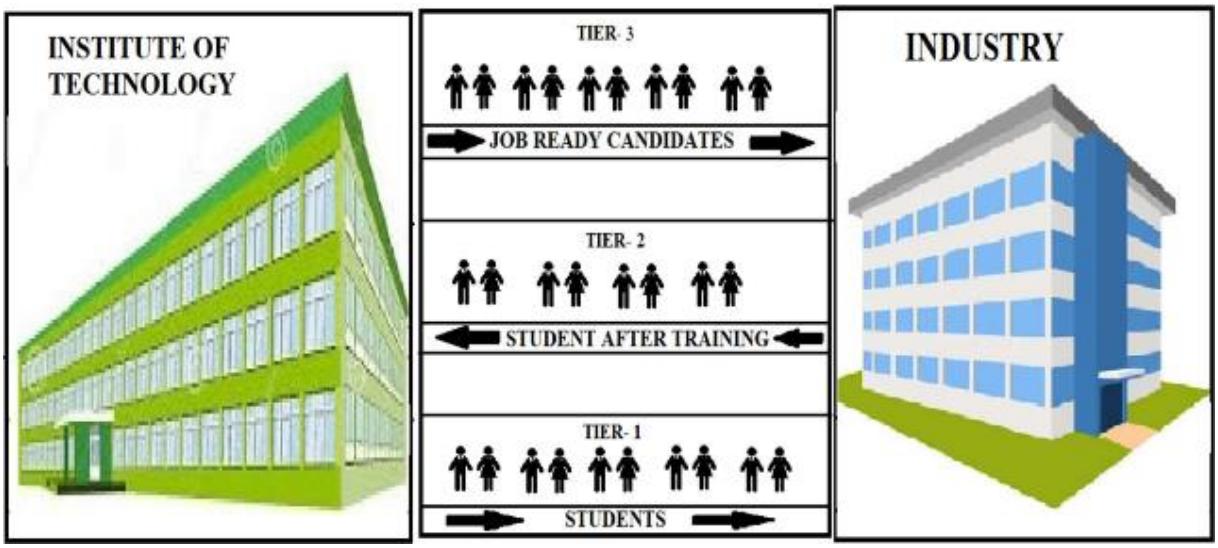

Fig. 1. *The proposed one model of 3-Tier movement to set the carrier of students*

- TIER-1: Student get training in Industry after learning basics in Institutes.
- TIER-2: After training more theories.
- TIER-3: Finally Job ready candidates go to industry for employment.

The proposed model of the 3-tier movement is a presentation of the concept. The different models need to be prepared according to the syllabi pertaining to different subjects' demands in respect of skill and hands on practice. For example, a subject on Manufacturing Technology with its various volumes such as different machining methodologies like turning, milling etc. are needed to be divided according to the weightage given in respect of theory and practical sessions. The practical demonstrations, then, may be sub-divided into in-house and out-house (Industry based sessions) accordingly, to fit into a tailor made model pertaining to the particular sector. The limitation of the paper therefore is to extend the unlimited opportunities to develop the curriculum in respect of the different subjects.

Conclusion

The proper contextualization of the concept and the content with the implementation of skill and

cognitive practices is well adoptive simultaneously with the classroom of chalk and talk sessions. The mission and vision of the recent approach of skill based learning will definitely help in the smart nation building. This has re-established the philosophy that by adapting of the attitude to bring positive changes nothing is really impossible. It only demands unbiased approach, right leadership, good management and methodologies with fully dedicated hard work, absolute integrity and total transparency. Different models for different objectives can be easily prepared to achieve the respective goals. Regular competitions in the respective areas should be held at the state and at the national level to reward the bests. Needless to mention that this will not only spread the awareness but also motivate the youth to be result oriented. We must always remember that our youth who are having great potential are our future. They must always be facilitated, supported and protected by us with great care, compassion and nourishment. They should be empowered with courage, conviction and confidence.

The learning with passion coupled with ethics can only be put during primary level. This will not only enable the tiny little to bloom but will make them responsible citizens. The building of the nation with patriotism will thus become visible naturally with rare chances of calamities and disaster. The youth are having a great potential to imbibe anything good. They have shown the proof in many ways. They were successful to learn digitally so well that they could overcome every challenge even during recent corona pandemic. Meeting in person is very much necessary to forge a deep bond of trust. It brings people nearer and together. The newly born Delhi Skill and Entrepreneurship University (DSEU) which has been established in August 2020 developed a new model by setting its vision and mission. It may induct first half theory and second half practice in the industry by and large. The worthy guideline is to ensure that the courses and pedagogy are continuously updated based on market requirements.

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5 Enhancing effectiveness of engineering education through experiential learning – a case study

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Abstract

In recent times, the ever increasing expectations for updated skills at workplaces, particularly at various industrial sectors have necessitated adoption of innovative learning solutions across the world. These expectations are also constantly changing due to various reasons, including adoption of latest technologies. To meet the emerging industrial needs and expectations, educational institutes are required to adopt innovative solutions for improving the skill sets of students to make them industry ready. Application of the relevant "experiential learning" methodologies could be very effective approach for facilitating quick learning and development of necessary skills by the participants. With a case study in the field of occupational safety and health i.e., enhancing effectiveness of employees is highlighted as it is based on learning by doing concept. Similar learning modules can be developed by the institutions to improve the engagement of students, facilitate holistic conceptualization, enhanced retention etc. during their tenure in the formal academic arena.

Keywords:
Industrial Requirements, Experiential Learning, Occupational Safety and Health

Introduction

Recent surveys conducted by various industrial bodies show that the large percentage of engineering students graduating from various educational institutes in India are not unemployable. Several organizations, leading industrialists, and apex body for IT BPM industry NASCOM state that only 15% to 25% of technical graduates are employable [1]. On the contrary to the earlier recruitment approaches, the corporate industries are currently focusing on practical and soft skills, and not just on academic qualification of fresh graduate engineers. This is due to the rapid growth in technology, the dynamic world economy, the increased influence of information technology, the ever-rising competition and globalization. This widening gap between industry standards and deficiency in skills of student's created huge turbulence in employment and retainability.

Owing to the gap between theory and practice the graduates joining the industry require up to about two-year gestation period for them to show their input in the company, in many situations they end up leaving the company without giving any input in the organization or company [2].

With the traditional teaching approach, often described as the teacher-centered, lecture-based approach, the instructor is actively involved in teaching while the learners are passive, receptive, and mainly listening. Even though they gain necessary academic/subject knowledge, students still lack in different areas, including technical abilities (design, testing, management tools etc.) personal skills (communication, collaboration etc.) and professional attributes. Hence, students need an opportunity to demonstrate their skills and impress their prospective employers to gain full-time employment. Their chances of success are enhanced by getting themselves involved in activities that blend theoretical knowledge with real-life practical experiences.

Experiential Learning

From the words of Aristotle, the famous Greek philosopher, "For the things we have to learn before we can do, we learn by doing."[3]. Experiential learning is a teaching and learning methodology that is becoming more recognized in the university education. It is the process of knowledge generation from direct experience [4]. learning as defined by experiential learning theory is the "process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience." [5] Experiential learning is, in essence, the process of developing new skills or knowledge through doing, rather than reading, watching, or listening. It is the most natural and effective way that we learn. As such, experiential learning has much better rates of engagement, long-term retention, and transferability than other methods of learning. Experiential learning lends itself to richer skill development. Experiential learning is an immersive, participant focused, active approach to learning that involves learners of all ages, backgrounds, and experience levels in an emotionally engaging learning experience. The benefits of experiential learning are many, some of which are stated here.

- Facilitates immediate applying of knowledge.
- Increases effectiveness of learning & Participant engagement
- Encourages collaboration and exchange of ideas and perspectives.
- Can be course focused or in-class, community focused, or work focused
- Combines direct experience with focused reflection
- Increases critical thinking abilities
- Increases memory retention

Case Study at a Construction Company: Safety Cultural Transformation through Experiential Learning

In the present globalized economic environment, sustaining the competitive edge is linked with overall organizational effectiveness. Occupational Safety and Health (OSH) and Quality at workplace plays a major role towards this direction. While striving to achieve excellence in operations through various initiatives, integration of Occupational Safety and Health (OSH) and bringing about a "Safety Cultural Transformation" in the organisation is the key enabler for sustainable development. The process of "Safety Cultural Transformation" requires a strong leadership that demonstrates commitment to safety as well as appropriate methods and processes to manage risk. To facilitate this aspect, it will be of vital importance to build skills for consistent implementation through effective training and communication.

Facilitating learning on Occupational Safety and Health through experiential methods is expected to be of immense help in creating long lasting and forceful impact in the mind of the participants. Recognizing this, L&T has taken up initiative to set up a world class "Safety Innovation Schools (SIS)" at L&T Hazira & Kanchipuram with focus on various activities and other aspects that are generally attributed.

This learning methodology at Safety Innovation School (SIS) is naturally different from formal theoretical safety trainings as it goes beyond providing mere technical inputs in a classroom setting. SIS has been designed to facilitate experiential learning with the usage of practical simulations in a meaningful manner to create the impact of practical experience and drive for EHS excellence and cultural transformation. This facility will cater to a wide spectrum of participants, including Senior

Managers, Construction Managers, Engineers, Supervisors as well as Supervisor/Safety marshals of subcontractors. Experiential training module has been designed for 3 days inclusive of theory as well as practical simulations, targeting front-line engineers and supervisors.

Concepts detailed in USDA Curriculum Development for Issues Programming Handbook (1992), used to develop the Experiential Learning Modules established at the SIS's. The experiential learning model provides a learning sequence that maximizes the learning process in a significant and meaningful way from the learner's perspective [6].

Safety Innovation schools house several facilities to impart experiential learning in regard to various aspects of construction activities. Some of the facilities developed focusing on Working at height, Confined Space, Fire Fighting, First Aid Treatment (CPR) and Virtual Reality Safety Experience provides the practical and real time experience for the participants to better understand the risks involved, importance of safety systems (Permit to Work) and correct usage of Personal Protective Equipment (PPE).

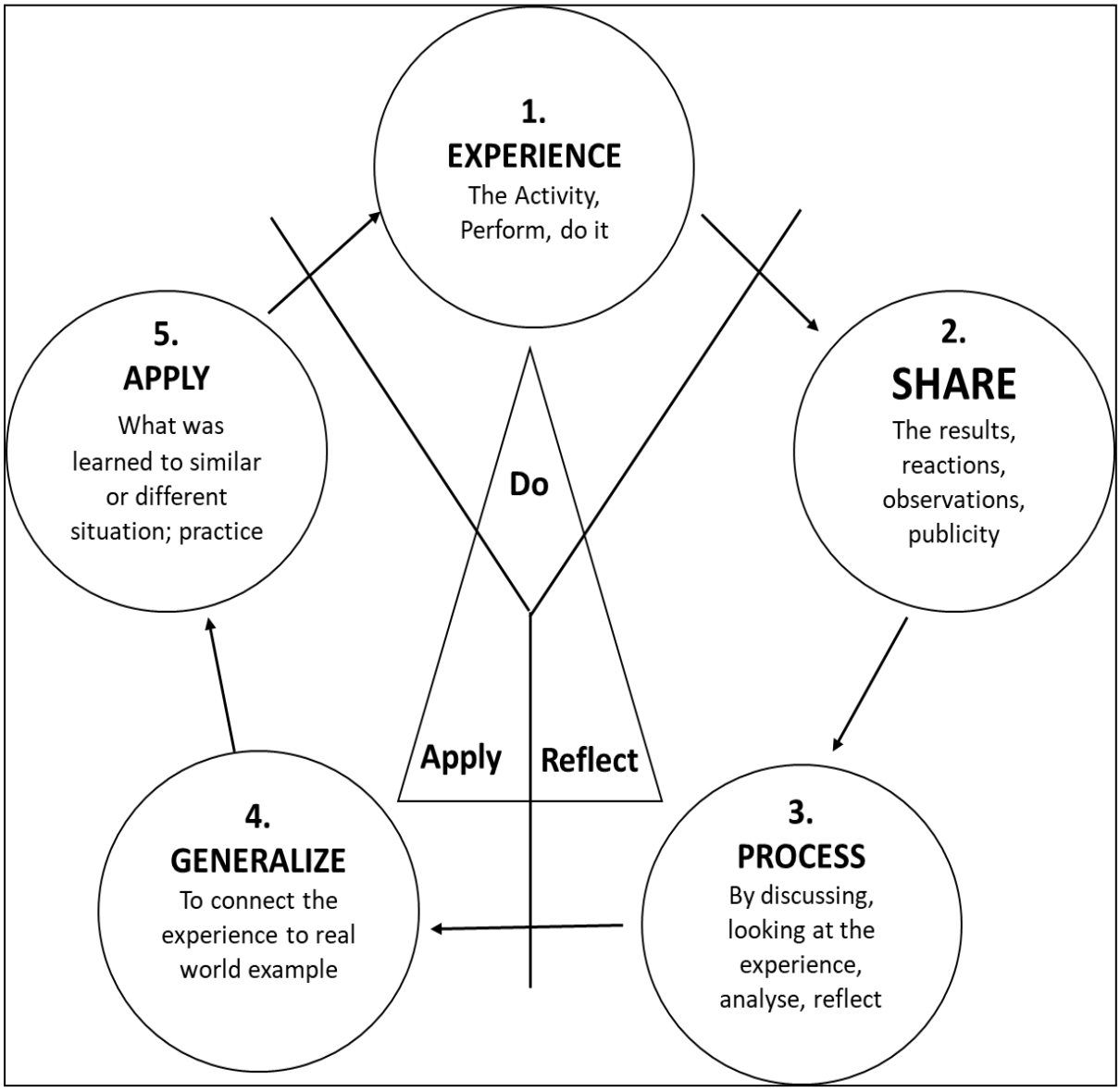

Fig.1. *The Experiential Learning Cycle Facilitator Guide*

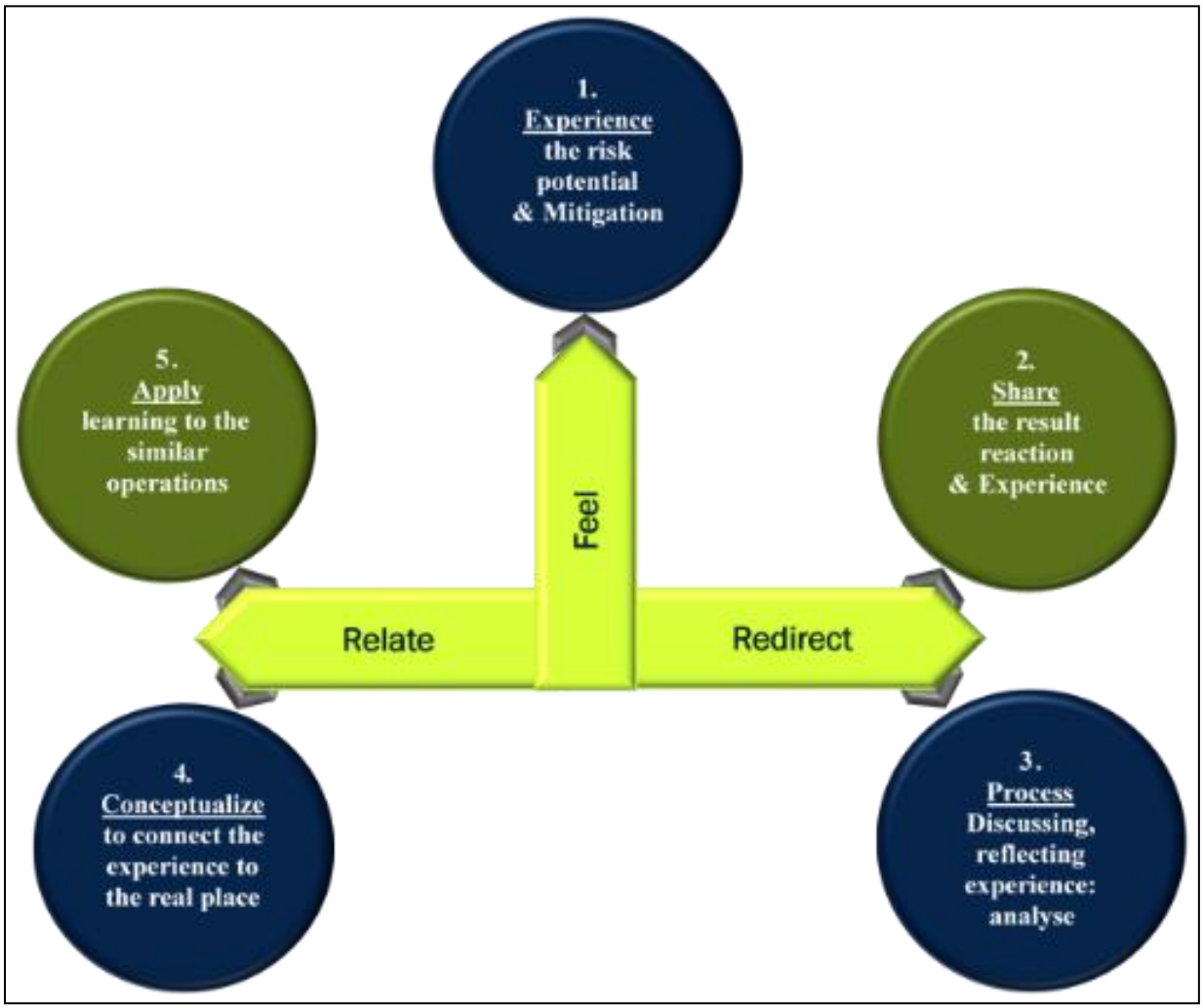

Fig.2. *Facilitator Guide for Experiential Module developed at SIS*

Fig.3. *CPR Training Mannequin for Hands-on Tutorial*

Application of experiential learning for cardio-pulmonary resuscitation (CPR) is a good example. (Figure: 3); Where participants are trained on how to impart CPR as a means of emergency first aid to the person in distress using Mannequin as a simulator. Through this process participants achieve expertise in CPR, right amount of pressure, frequency, timing etc. as well as important do's and don'ts.

Fall from Height (Figure: 4(a) & 4(b)); Participants walk through simulated unsafe working platforms, with openings, uncovered edges, small gaps etc. and experience the hazards of fall and realize the need of taking safety measures while working at height. They also experience a free fall (safely) to the cushioned ground surface to feel the instantaneous psychological and physical impacts of any unexpected fall, which could be more serious. Through this experiential process, the participants realize the risks of falling from height and the importance of providing safe working platforms, safe access and fall protection measures for working at height.

Fig.4(a) & 4(b). *Fall from Height Simulation*

Fig.5. *Awareness on Suspension Trauma*

Suspension Trauma (Figure: 5); Participants experience the moderated trauma, discomfort and pain in the event of fall and suspension, even while using full body harness correctly. Suspension trauma/Harness hang syndrome is caused due to delayed rescue in case of fall while using full body harness. Suspension trauma can lead to loss of consciousness due to a victim being held upright with limited movement for some period of time, which can be fatal if not addressed promptly. This underlines the importance of a robust emergency management plan backed by sound rescue procedure and availability of skilled rescue personnel.

Firefighting (Figure: 6); Participants trained in usage of various types of fire-extinguishers including structure and operation of fire extinguishers based on type of fire involved, different fire extinguishing methods such as smothering, cooling and subtraction/ elimination of fuel or oxygen and salient safety aspects involved in firefighting. Through this process participants realize the significance of availability of various types of firefighting equipment, awareness among individuals regarding selection of fire extinguishers and their operation.

Fig.6. *Firefighting Tutorial Based on Material Involved*

Gas cutting (Figure: 7); Participants trained on safe operation of gas cutting, importance of safety devices such as flashback arrestors and various preliminary checks such as hose pipe inspection, inspection of cutting torch & cleaning and gas leakage detection etc. Through this process participants realize the severity of hazards involved in gas cutting activity safety, significance of suitable safety devices and the role of pre-work inspection and compliance with safe operating procedure.

Fig.7. *Inspection of Compressed Gas cylinders and Gas Cutting Set*

Inspection of tools & tackles (Figure: 8(a) & 8(b)); Participants trained on detailed inspection of tools and tackles to identify any defects, standard operation of various tools & tackles such as slings, pulleys etc., and the importance of proper upkeep of the tools & tackles. Through this process, participants pick up the nuances of selecting proper tools and tackles for safe operation, while promptly identifying any damaged tools so that any accident can be averted.

Fig. 8(a) & 8(b). *Inspection of Various Tools & Tackles*

As the learning process is a hand-on-experience with the various aspects of construction work and the real-time exposure to the hazards activities, even though majority of them are aware of the hazards involved in these activities, with these experiential facilities, participants get to experience the probable severity of these hazards and the role of safe processes and safety devices to prevent major incident/injury. As they are subjected to these in-person, change in participants' perspective about OSH get evidenced. It was also justified by the feedback received from thousands of participants who were covered under hundreds of sessions suggested that these facilities made them understand the risks associated with the construction activities in a better manner and the content of the course had created a new outlook in their mind sets on implementation of learning at their respective workplaces with the rejuvenated perspective.

To improve the learning capabilities and better understanding of subject knowledge, experiential learning can be incorporated into the curriculum of Universities/Institutions as hands-on learning is considered to be the effective means of learning globally. This can be facilitated to the students via,

- Setting up of Incubation Centres
- Industry Institute Partnership
- Project-Based Learning – Model Development or Prototype/Design Building
- Research Based Learning
- Interactive classroom sessions – Mock trails, interviews, drills etc.

Conclusion

Industry expectations for new engineering graduates are continually changing**.** Owing to several reasons, the conventional way of teaching students, where students mostly learning by listening in classrooms does not provide them with the skills that they need to succeed as professionals. It is broadly accepted that hands-on exercises that display physical, measurable representations of mechanical realities are able to form connections between engineering predictions and the physical world in meaningful ways. Experiential learning facilities named as "Safety Innovation School" established by L&T illustrated this concept in a unique way. These facilities extend the opportunities for holistic understanding of the work areas and the activities and enable them to opt for safer work practices which in turn resulting in better organisational occupational safety and health performance. Deployment of the concept of experiential learning in engineering education with focus on hands-on engagements at simulated industrial scenarios can enable them to be more effective and productive at work in the shortest possible time.

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6 A Novel Teaching Methodology for Invisible Disabilities and ASDs

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Abstract

There is a spectrum of disabled disorders. The invisible disabilities, autism spectrum disorders (ASDs), deficit in language comprehension or deficit to or in-attention, epilepsy, mental disorders, or the syndrome like chronic fatigue syndrome are the example of a spectrum of disorders. With the advancement of technologies, the educational environment/tools are also developed from classroom-oriented teaching-learning processes to online (e-Learning) based teaching-learning processes. It is comparatively easy to design pedagogy for the normal student. But when the question arises like the teaching-learning process in e-Learning mode for those with disabled disorders, it's quite different from others. Because education is the only condition of development to develop their learning-skill, communication skill and social-interaction skill or the holistic development. A disabled disorder like autism is a series of development disorder which impacts the ability to communicate and interact on a social setting. It can be diagnosed at any age; basically, at the first 2-5 years. Day-by-day, the population of autism is vastly growing. More than 1 million cases happen per year in India. As per the neuroplasticity's theory; thinking, learning, and acting that changes both the brain's physical structure which is called "Anatomy" and the functional organizations which is called "Physiology". The Indian education system is one of the oldest education systems where it has a direct impact on the human spiritual learning system. There are spectrums of invisible disabilities and autism; but for the case of autism everyone has a common problem with communication; but not in the same way. Here, we proposed a framework for them where the system is suited for the development of holistic development of a learner those who are belonging from invisible disabilities and ASD. Assessment is an integral part of a teaching-learning process. The proposed system also provides a framework for the development of the assessment techniques so that the system itself is able to find out the deficiency areas of a topic, and, it provides the related learning object metadata. The system develops their learning skills, social skills and communication skills, and self-reliance, and make them Atmanirbhar.

Keywords: Invisible disabilities, Autism, Conventional education, e-Learning, Assessment.

Introduction

With the advancement of Science and Technology, e-Learning has a vital role in the modern education system. A special type of aesthetic in-nature e-Learning system is needed where it focuses on the holistic development of a learner. A special type of online teaching technology is required where it develops the inner and outer parts of a learner. Here, we categorise our work into different sections firstly, discussing in brief about the ancient Indian education system where it describes the overview of that education system that develops holistic development, thereafter, e-Learning and its recent trends. Besides, it shows various surveys related to the Indian education system and the quality of the

teaching-learning process, and the outcome of it. Then, we proposed a framework for advanced technology-enabled learning for Invisible disabilities.

Aim & Objectives

Assessment is an integral part of teaching-learning process. The aim is to design and develop a special assessment model that find out a learners' deficiency areas and provide the related learning object metadata to the learners. It is a pre-defined process for designing, selecting, evaluating, interpreting and collecting information of a learner and evaluating and giving positive/negative reinforcement. Holistic development that means the development of a learners' inner and outer part like "intellectual", "mental", "physical", "social-abilities" and "emotion"; so that the learner is capable of facing the challenges and the demands of everyday life. The objective is to design the proposed system in such a way where it has a direct impact for the holistic-development of invisible disabled learners and ASDs.

Fundamentals

Invisible Disabilities and Autism Spectrum Disorder

"…invisible disabilities, also known as hidden disabilities. These are all a special type of disabilities that are not apparent at the very first time when the children are of two/three-year-old. These are also a typically chronic type of illnesses and mental/physical conditions that impair the normal behaviours of day to day life."[1]

For example, approximately people with "visual or auditory disabilities" who are not found to wear eyeglasses or hearing aids or those who use discreet hearing aids, may not be disabled. Few people who have "vision loss" may wear contact lenses. It is assessed that 1 in 10 persons living with an "invisible disability".[1]

On the other hand, autism spectrum disorder (ASD) is a series of serious developmental disorder that impairs the ability of social communication. There is various type of Autism. In the USA only, 1 out of 54 children is diagnosed as autism in 2018 as per the report of Centres for Disease Control (CDC). It also has a direct impact in eye gaze. As per the CDC; there is no certain medicine that can cure autism at a glance. But education is first and foremost condition that has an impact for the case of ASDs. There is a challenging issue to design and develop an education system in e-learning mode that is suited for the ASDs children.[2]–[4] The effects of ASD and the symptoms are varying from person to person. Most of them are not able to express their spoken language. Words are like a second language for autistic children. But, the children like ASDs have a special and unique capacity to translate the spoken words and written word into various sequences of images such as a Video-cassette recorder to their head/brain. When somebody speaks to them, the words are instantly translated into pictures. There are spectrums of autism but everyone has a common problem with communication; but not in the same way. There are few symptoms of Autism, for instance, they avoid eye contact or poor eye contact, abnormal tone of voice and monotonous speech, abnormal body posturing or facial expressions, deficits in language comprehension, delay in learning to speak, inappropriate social interaction, and lack of empathy, intense focus on one topic, behavioural disturbances, repeating words or phrases & movements, and deficits in language comprehension, etc.

Birth Year	Surveillance Year	This is about 1 in X children
1992	2000	1 in 150
1994	2002	1 in 150
1996	2004	1 in 125
1998	2006	1 in 110
2000	2008	1 in 88
2002	2010	1 in 68
2004	2012	1 in 69
2006	2014	1 in 59
2008	2016	1 in 54

Table 1. *Autism and Developmental Disabilities Monitoring (ADDM) Network-2000-2016*

According to the ADDM Network: - "…it is an active observation program that offers approximations of the prevalence of ASD among children aged of 8 years old whose parents live in 11 ADDM Network sites in the United States (Wisconsin, Colorado, Arizona, Georgia, Arkansas, Maryland, Tennessee,

Minnesota, New Jersey, Missouri and North Carolina).[3] Surveillance is conducted in two stages: - the first stage encompasses review and abstraction of comprehensive evaluations that were finalized by medical and educational service providers in the community and; in the second stage, experienced clinicians who thoroughly review all abstracted statistical reports that determine ASD case position. The case definition is based on ASD conditions described in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition…".[3] In Table 1, all the above Data are collected from "Centers for Disease Control and Prevention". ASD is increasing more than four-times common among the boys than among the girls.[3]

Education System in India

Ancient education system in India evolved throughout the period and it focused on the holistic development for every student by taking care of them in a way where the main aim of education was the development of both inner-self and the outer-self of the learners. [5][6] At that time the learning system was also famous to the world where learners came from various places throughout the world. There were various world class educational universities. Nalanda is one of them and it is oldest universities in the world. It also declared as a World Heritage site by UNESCO.[7] The modern education system was brought to India originally by Lord Thomas Babington Macaulay in the 1830s where English language was taken as Second\First language of learning.[8] From that time, all the subjects began to be taught in the English language in higher-education. As a global communication, English is accepted everywhere instead of Sanskrit or another mother tongue.[5][6] This is why there was a revolution of the ancient Indian education system in India.[7] But, nowadays in Germany, 14 universities teach Sanskrit and about the ancient Indian education system.[9] Now, the course curriculum is confined to "modern" subjects like mathematics and science, and other subjects such as philosophy and metaphysics are considered to be unnecessary. Teaching is limited to classrooms and the relation with nature has broken along with the close connection between the teacher(Guru) and the learners(Shishya). The school system in India has 4-levels: a. lower primary (age: 6 to 10), b. upper primary (age: 11 and 12), c. high (age: 13 to 15) and d. higher secondary (age: 17 and 18). All are mostly book/class-room oriented education system.[10]

For design and development of a novel learning system, it is required to understand the quality of the learning in the conventional learning system. It takes into account various studies for education and learning outcomes. Annual Status of Education Report (ASER) is one of the famous national wide survey that provide the status of the quality of learning basically for the primary and elementary school students.

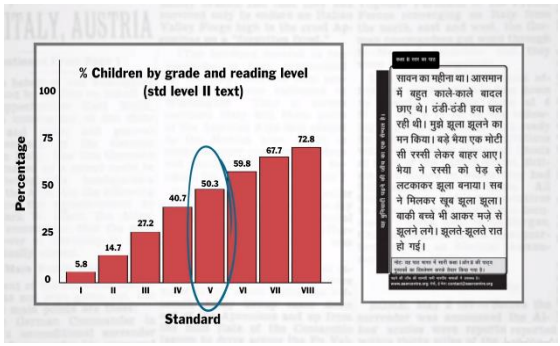

Fig. 1. *ASAR survey report for Reading Comprehension Test[11]*

Figure 1 portrays that student who have passed till VIII, but 50.3% of these students can read a text which is from the class II standard. So, it depicts the quality of a teaching-learning process in the schools from rural areas in India. Besides, the report also tells that only 4.4% of children are not going/admitted to any school. 95.6% of children are going to school. But the question always arises as to "what is the quality of the education?" [12]

Here, we categorise the education system as: - i. How to teach the students or the Design of the System, ii. The Governance of the School/Institutes. Besides, according to the survey done by Economist Karthik Muralidharan and Abhijeet Singh, the level of learning is not achieved in most of the cases; as compared to the degree awarded.[12]

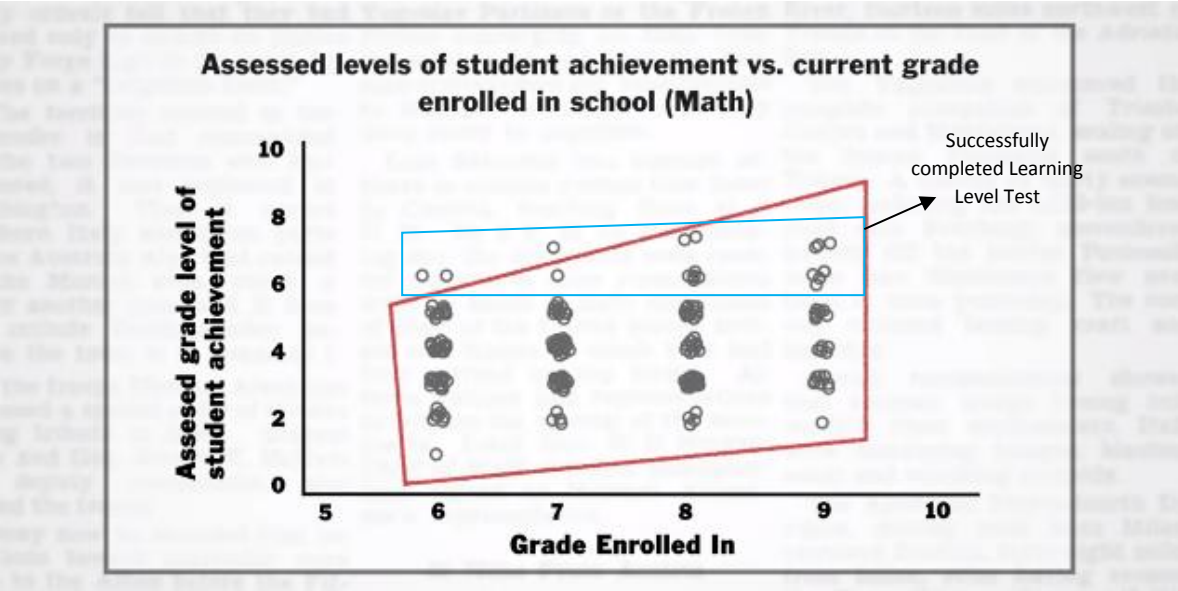

Fig. 2. *Assessing the Learning Level by the Economist Karthik Muralidharan and Abhijeet Singh[12]*

In Figure 2, the blue line represents the achievement of a level of learning, and the red line represents the level of learning that is not achieved yet as per the degree awarded to the students. In most cases, students have a lack of pre-requisite knowledge and skills for most of the students inspite of degrees being awarded.

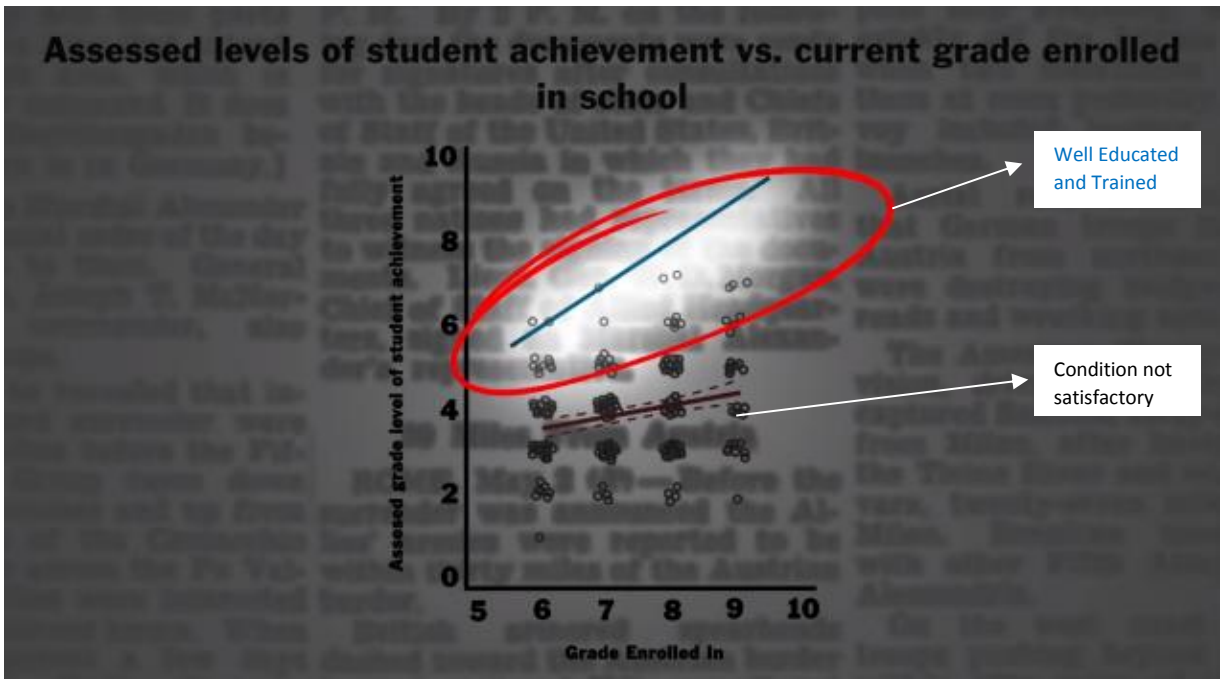

Fig. 3. *"Minimum" of Achieve Desired Learning Level;*
"Maximum" of not achieve the Desired Learning Level[11]

In Figure 3, Economist Karthik Muralidharan and Abhijeet Singh pointed out the learning level of the urban private school/institute students. Here, it is shown that the students are promoted to the higher classes; but the level of learning is comparably lower than the desired level. It means that "the students are well trained; not well educated".[12], [13] That's why a smaller number of students are successful in higher educational institutes or other activities like job, placement etc. The impact of it has been continued throughout the life. [14]

From the above brief discussion, it has been identified that a novel teaching-learning system

is required that must be divided into two categories on basis of the finding the deficiency areas. So, the two categories are: -

- Skill development
- Filter Students

E-Learning

With the advancement of science and technology, there is a revolution in the teaching-learning process. The education is shifted from conventional learning or classroom centric learning process to online student-centred learning process. As earlier discussions, the novel system is required to be divided into said two categories namely skill development and filtering the students. But, for the case of Invisible Disabilities and Autism Spectrum Disorder students, the system should act as a self-assessment model also. The system can identify the deficiency areas of a learner who belongs to a disabled disorder.

Problem Identification

As per the discussion of the above case studies and survey reports, it is also required to have a novel education system that focuses on the skill-development of a particular deficiency area and after that filtering the students with the help of standard assessment techniques in the e-Learning system, also, providing the necessary metadata related to Learning Object Metadata for that deficiency areas. Besides, a novel system is required for synchronous and asynchronous mode of e-Learning for the Invisible Disabilities and Autism Spectrum Disorder students.

Framework Design

Proposed Special Educational Model

There is always need for special education for the said two disabilities conditions. The ABC Model is a special educational tool that can help the students who belong to those two categories of students to examine their continuous behaviours that change from time to time and the triggers behind those behaviours, and the effect of those behaviours on negative or "maladaptive patterns". The first phase namely Antecedent and the second one Behaviour Focuses on "Consequences of Actions". The process will be continued till the development goal(s) are matched.

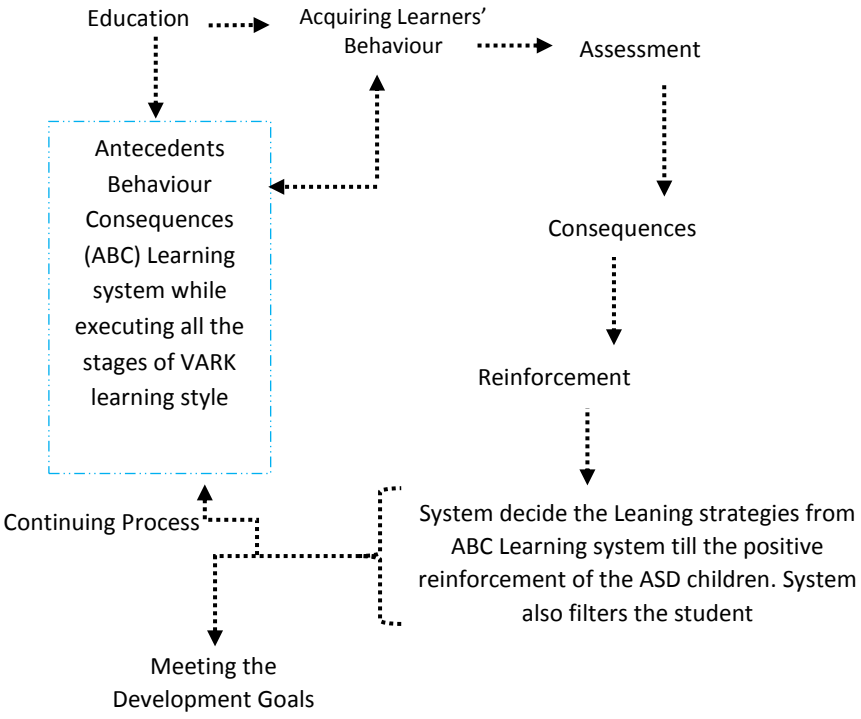

Fig. 4. *Proposed Special Educational Model*

Proposed System Design Model for Improvement the Teaching-Learning Qualities for Invisible Disabilities and ASDs

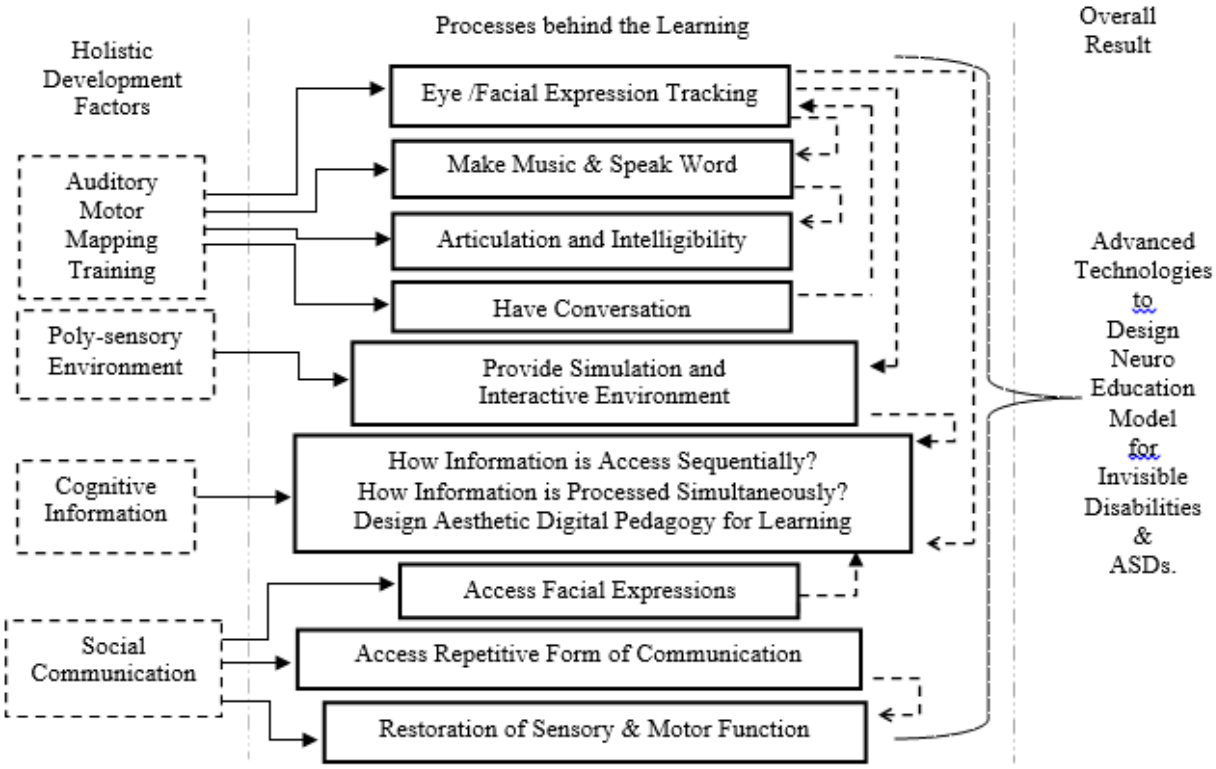

Fig. 5. *Proposed System Design Model for Improvement the Teaching-Learning Qualities for Invisible Disabilities and ASDs*

We want to merge the ABC learning system with the VARK learning style where all the processes will be successful, completed continuously.[15] Besides, a system needs to be developed that deals with the process of developmental consequences named as positive reinforcement.[15] Instead of AMMT and interactive multimedia-enabled learning process, we will use the holistic education of the Gurukul system that will develop their both inner-self and the outer-self of the learners.[16][17] Life-skilling needs to be learnt by ASD children, that leads to their improvement of neuroplasticity. After a continuous process of a proposed learning system, they will be able to overcome their disabilities/barriers without implanted micro-chip inside the brain for a lifetime. We categorise different human factors related to holistic development, - auditory motor mapping training system, poly-sensory environment, cognitive information, and social communication.[18] According to various surveys and analyses, we mapped it with the various process behind the learning.[11][12][13] Few of them are unexplored research areas. After that, we mapped and denoted it as the Neuro Education model for the Invisible Disabilities and the ASDs students.

Proposed Framework for Synchronous and Asynchronous Mode of e-Learning

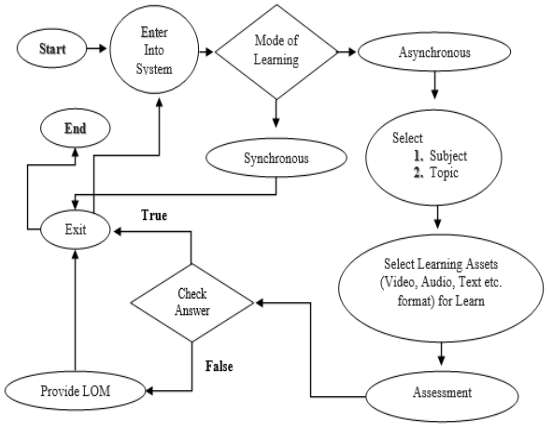

Fig. 6. *Flowchart for the Process of Learning to Assessment*

Learning Object Metadata (LOM) and the Assessment

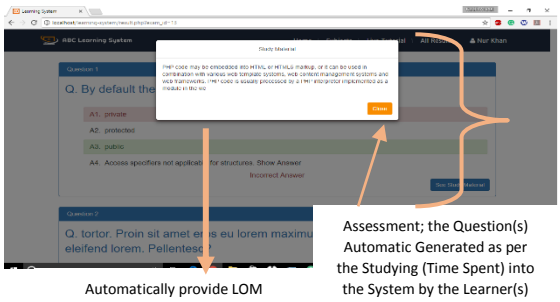

Fig. 7. *Implementation for Assessment and LOM Provide*

The sentences are mapped with topics using "Latent Dirichlet Allocation".[19] Our proposed model designed the questionnaire by collecting the text documents. After that, it models the topic which the learners learn in the asynchronous mode of learning. From each of the topics, there will be a cluster of words by the respective topic(s), and, after that, the cluster of sentences in the topic(s). It extracts certain groups of topic(s) according to the topic system fed to it. After the finalization of the questionnaire according to the topics, several processes are carried out by it. On the other side, LOM is a special type data model. It is usually encoded in Extensible Markup Language (XML). XML is normally used to define a learning object and related digital resources (Multimedia) that are used to support learning in both synchronous and asynchronous modes of e-Learning. [20], [21]

Discussion

The proposed framework has two parts, one is front-end and another is back-end. The front-end deals with the special education model design part. The back-end deals with the software implementation parts for acquiring different factors for understanding better teaching-learning outcomes. In Figure 4, we apply the ABC Learning system for e-Learning where all the stages of learning information in form of VARK(Visual, Aural, Read/write, and Kinaesthetic sensory modalities) learning style is applied for the teaching-learning process.[22] While educating, the system continuously acquires the learners' behaviour. After the assessment, the system checks the consequences of it. In Figure 5, the various factors are analysed that are related to holistic development for the invisible disabilities and ASD.[23] After that, there are various processes which will be continuing behind the session of learning. After combining different factors and sessions of learning, it will be a neuroeducation model for invisible disabilities and ASD. The proposed system is also applicable for normal students those who are not related to invisible disabilities and ASD. It will improve their learning skill on the basis of topic(s).

Conclusion

Here we proposed a framework for special education system that will be useful for holistic development basically for the invisible disabilities and ASDs students. Day by day, the population of invisible disabilities and ASD are vastly growing. Education is the only way to develop their learning, social, and communication skills. So, an advanced technology-enabled teaching-learning process has been required from long ago. The proposed system is suited for both synchronous and asynchronous modes of e-Learning. It is designed in such a way, where the user interfaces design of the e-Learning content is based on the ancient Indian education system. It also discussed the techniques of automatic question generation from a particular topic. Besides, here the system is proposed in such a way where it provides the automatically generated questionnaire to the students as per their time covered topics into the asynchronous mode of learning. In future, there is a scope to design an e-Learning system that should be "aesthetic in nature" for the individual learners for both the cases of the synchronous and asynchronous mode of e-Learning basically for the invisible disabilities and ASDs. Besides, there is also a scope to implement a system of entrepreneurialism. It will also be helpful to design online pedagogy for aging learning. Further, there is a scope to implement a psychometric assessment tool from the proposed assessment techniques which are described here. The system will also help in developing their learning skills, social skills and communication skills, and self-reliance, and makes them Atmanirbhar.

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7 Face Identification and Recognition of STTP Participants of NITTTR Kolkata with the Integration of Feature Extractor and Machine Learning: A Comparative Study

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Abstract

Human face is considered as a significant characteristic in order to recognize a person. This can be attributed to the fact that every human being has his/her unique identity. As a consequence, face detection system has been introduced in various fields ranging from biometrics to banking system. Human face is a dynamic object with high variability due to its changing expressions, looks etc. Therefore, face identification and recognition are important tasks. Moreover, feature extractors are also used in this regard in order to do the feature engineering for getting better accuracy. Here, we have conducted a comparative study in order to identify and recognize the faces of the STTP participants of NITTTR Kolkata. In this regard, different feature extractors like Local Binary Pattern and Histogram Oriented Gradients along with different machine learning methods such as K-Nearest Neighbors, Naïve Bayes, Decision Tree, Support Vector Machine, Artificial Neural Network and Random Forest are used in integrated fashion. The machine learning methods are trained on in-house curation of 42 images of five participants and a coordinator. The results show that Histogram Orientation Gradients integrated Random Forest is superior to other as it gives 100% accuracy while identifying and recognizing the faces of the participants.

Keywords: Face Identification, Face Recognition, Feature Extraction, Machine Learning.

Introduction

Face identification and recognition is one of the most rapidly advancing and challenging domains in the field of computer vision. Currently, its involvement in the human life can be noticed easily in myriad of applications ranging from phone face detection to the autonomous driving car. Hence, face identification and recognition lead to achievement of autonomous task where machine has to act accordingly to the surroundings. In the past decade, many different algorithms are designed such as Scale Invariant Feature Transform (SIFT) [1], Speeded Up Robust Features (SURF) [2] and memory-based cognitive [3] model for face identification and recognition [4]. Moreover, involvement of machine learning (ML) in face recognition has gained wide acceptance due to its reliability and robustness to predict multiple faces with good accuracy. It is important to note that accuracy of the machine learning (ML) models relies on feature extraction methods like local binary pattern (LBP) [5], histogram-oriented gradients (HOG) [6], and Grey Level Co-Occurrence Matrices (GLCM) [7] which directly affects the performance of the machine learning methods [8].

Ahonen et al. [9] represented the human face as shape and texture information for classification. To achieve the same, they distrusted the whole face into several small windows and extracted the LBP features from each window locally and later in joined single, spatially feature histogram as a feature matrix for training purposes. Another recent method proposed by Tong et al. [10] focused on face detection regardless of the image interferences named as multi-mirror local binary pattern where they carried out a two-phase process to extract the features from an image. Initially, to focus on the illumination of each face, it is represented in form of symmetrical singular value decomposition along with the LBP feature extraction. On the other hand, Girish et al. [11] combined the local and global features. For such histogram, each part of the image was created consisting of local features obtained by Multi Scale Block Local Binary Patterns (MSBLBP) whereas global features were obtained with the help of principal component analysis (PCA). As a result, they found MSBLBP to be more effective than PCA.

Face recognition using image features is quite a challenge due to many factors such as luminosity, colour difference, changing backgrounds, shapes and sizes of the face. Hence, Mohammed et al. [12] proposed a Human Face Detection model using the HOG Feature Extraction and compared the performance with the state-of-the-art models to provide the effectiveness of the HOG features. For the Human Face model, they used a Support Vector Machine (SVM) with a suitable kernel. The proposed fusion of HOG descriptors and SVM classifier achieved an accuracy of 99.86%. A similar work was proposed by Singh et al [13]. They used HOG feature extraction algorithm and Principal Component Analysis (PCA) for better extraction of relevant features for face recognition. Another similar work of HOG feature extraction and machine learning (ML) classifier were proposed by Putra et al. [14] for vehicle detection. They proposed a vision-based vehicle detection system which were composed of three main components: HOG features for feature extraction, K-Nearest Neighbor (KNN) classifier for classifying the region of interest (ROI) whether belonging to a car or not and vehicle detector model to identify the particular vehicle. The proposed framework achieved an accuracy of 84%.

On the other hand, as most of the literature focused on face extraction using 2D images, Shi et al. [15] proposed a 3D face recognition method which uses LBP for feature extraction of 3D face depth image and SVM classifier to classify the feature information obtained from LBP descriptors. Both LBP and HOG algorithms help obtain features from the image. Manju et al. [16] proposed a novel approach of face recognition in surveillance videos. They used HOG and weight LBP features which were used by a novel pose-invariant Orthogonal Locality Preserving Projection (OLPP) algorithm for recognition of face

Motivated by the literature, this study focuses on the comparison amongst different feature extraction and machine learning methods for face identification and recognition of the participants of Short-Term Training Program (STTP) at NITTTR, Kolkata. For such comparison, local binary pattern (LBP) [5] and histogram-oriented gradients (HOG) [6] feature extraction methods are considered to represent

the faces as feature vector for our classifiers such as K-Nearest Neighbors (KNN) [17], Naïve Bayes (NB) [18], Decision Tree (DT) [19], Support Vector Machine (SVM) [20], Artificial Neural Network (ANN) [21] and Random Forest (RF) [22]. The remaining part of the study is distributed as follows. Section 2 discusses the feature extracting methods, the classifiers used in this study along with the data acquisition and the pipeline of the study as methodology. Section 3 discusses the comparative results of each method. Finally, a conclusion along with the future scope is discussed in Section 4.

Materials and Methods

In this section, a brief description of the feature extractors and machine learning methods are provided followed by the details of data acquisition. Also, the pipeline of the study as methodology is put forth in this section.

Brief Description of Feature Extractors

Local Binary Pattern [5] (LBP) is a feature extraction method used in pattern recognition tasks such as face detection. LBP works on representing an image into small scale by considering the threshold of center pixel value of a sliding block of 3x3 over an image matrix. This operation is carried out using Equation 1 as given below.

$$\delta(x_c, y_c) = \sum_{n=0}^{7} 2^n . g(I_n - I(x_c, y_c)) \quad \ldots(1)$$

where, δ is the LBP value at the centre of the pixel of the block, and I_n and $I(x_c, y_c)$ are the intensities of the neighbourhood pixel and centre pixel respectively and function $g(x) = 0$ if $x<0$ and $g(x) = 1$ if $x>=0$. Most importantly, LBP performs better even in the robust monotonic grey level images as well as in challenging real time scenarios.

The main idea behind the Histogram of Oriented Gradients [6] is to represent the localized part of an object and its shape in the form of intensity distribution of the gradients. The principle behind the histogram of oriented gradients descriptor is that local object appearance and shape within an image can be described by the distribution of intensity gradients or edge directions. The x and y derivatives of an image (gradients) are useful because the magnitude of gradients is large around edges and corners due to the abrupt change in intensity and we know that edges and corners pack in a lot more information about object shape than flat regions. So, the histograms of directions of gradients are used as features in this descriptor.

HOG algorithm works on the occurrence of the gradient orientation in the local part of the image, focusing on the shape and structure of the object in the image. Initially, gradient of each pixel is calculated according to Equations 2 and 3.

$$G_x(r, c) = I(r, c + 1) - I(r, c - 1) \quad \ldots (2)$$

$$G_y(r, c) = I(r - 1, c) - I(r + 1, c) \quad \ldots (3)$$

Magnitude and phase of each gradient are then evaluated according to the Equations 4 and 5 respectively

$$\alpha = \sqrt{G_y{}^2 + G_x{}^2} \quad \ldots (4)$$

$$\theta = \tan^{-1}(G_y/G_x) \quad \ldots (5)$$

After obtaining the gradients according to the aforementioned Equations, gradients are distributed into bins depending on the magnitude and direction of the bin selected. The most important feature of the HOG descriptor is that its magnitude increases whenever there is a sharp change in the intensity of the image, for example, near the edges of the object. Therefore, HOG works similar to that of edge detector but it is better due to fact that it takes into account the magnitude and angle of the gradient. Further these gradients are used to construct histogram by distributing the image into cells which is further used for distributing each pixel intensity into separate histogram bin. As an image is easily influenced by external factors such as lightening which can easily affect the histogram values, therefore normalization is carried out in the histogram vector within each cell.

Brief Description of Machine Learning Methods

Recent studies demonstrate that machine learning (ML) methods help in image analysis and extract relevant features from the images. Due to this advantageous property, we use

different ML methods in order to recognize the face from the input features provided by HOG and LBP feature extraction methods. A brief description of the different ML methods is next put forth.

K-Nearest Neighbors (KNN) is a ML method proposed by Friedman et al. [17] which uses distance metrics to categorize the image data. After the distance metrics calculation, KNN classifier selects the first K category value and perform majority voting to classify the image.
Naïve Bayes (NB) [18] is another ML method which follows Bayes theorem. The important part of the whole classifier is the use of Bayes theorem, where probability of a single event (E1) known as hypothesis, is calculated when the other event, known as evidence has already taken place (E2). The key point of this algorithm is that it considers each feature independent of others during classification i.e., one feature does not impact the other.

Decision Tree (DT) [19] is a supervised learning approach in which data is distributed under different conditions. It is a non-parametric approach which is used for both regression and classification tasks. Prediction is carried out on the basis of decisions rules based on the data features.

Support Vector Machine (SVM) proposed by Fan et al. [20] is another supervised machine learning algorithm which helps in classifying the data. This is achieved with the use of different kernels that transforms the data into a particular dimension through which the best hyperplane is selected. This hyperplane separates all the data points into its corresponding classes. Classification of the data point is done through finding optimal *N*-dimension hyper-plane in order to classify data in one class or other where *N* is decided by the number of input features of the data.

Artificial Neural Network (ANN) classifier proposed by Dreyfus et al. [21] is a collection of connected neurons with activation function layers present in between these neuron layers to produce non-linearity which enriches feature representation that produce robust results. One main advantage of ANN over others is it does not require any kind of pre-processing over the data. Hidden layer also known as neurons tends to extract the pattern within data points which is further used to classify the unknown data points.

Random Forests (RF) [22] are a form of ensemble of uncorrelated multiple decision trees in which each decision tree have its own individual predictions and the most weighted tree becomes the final prediction of the classifier and free of any bias.

Data Acquisition

The 42 face images of participants of NITTTR, Kolkata are collected from a STTP where five participants viz. Siddhartha, Debasmita, Bikshan, Pranjal, Vijay and coordinator Indrajit are present. The sample training images are shown in Figure 1. Generally, images contain different face expressions with different brightness and contrast as luminance.

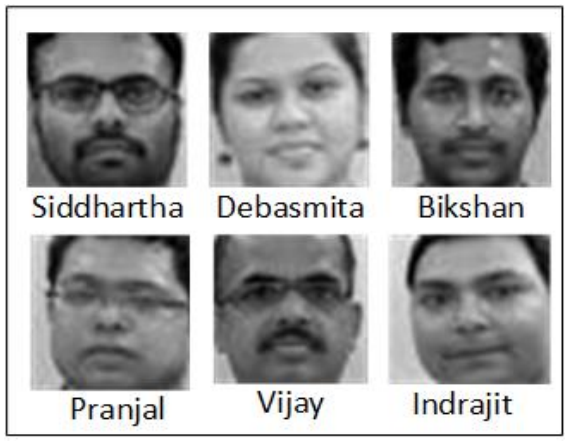

Fig. 1. *Sample images of participants and coordinator of a STTP of NITTTR, Kolkata*

Methodology

Initially, for training purpose 42 images of the five participants and a coordinator of STTP, NITTTR, Kolkata, are fed into cascade object detector which uses Viola-Jones algorithm in order to detect the faces. The details of the algorithm can be found in [23]. As a result, we obtain the training and testing images as faces of individuals. Followed by this, training images are resized to 20x20 dimensions, thereby producing a feature vector of normal image of size 400x42. While moving on to further stages of the study, feature extractor such as LBP and HOG are used to extract much more significant features from a normal image. Consequently, multiple feature representations are obtained in the forms of 59x42 and 36x42

feature vector from LBP and HOG respectively. Followed by which, all the three feature vectors i.e., 400x42, 59x42 and 36x42 are used for six different machine learning methods such as KNN, NB, DT, SVM, ANN and RF respectively. The pipeline of the aforementioned steps is given in Figure 2.

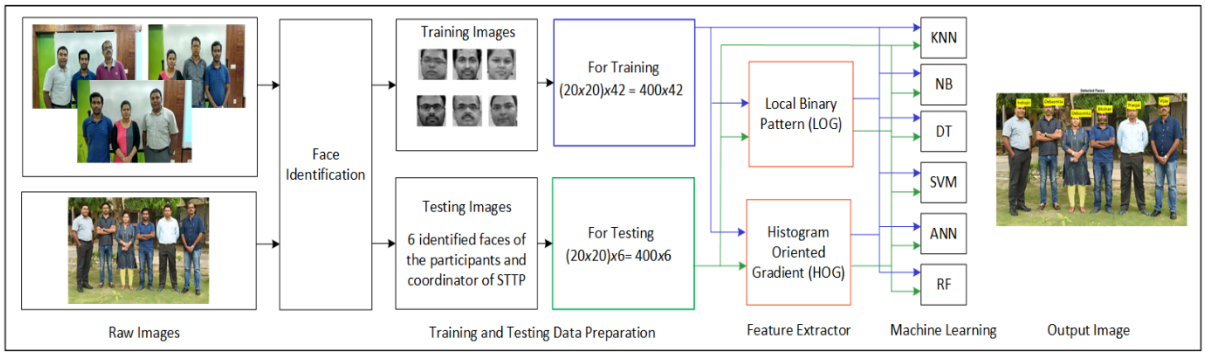

Fig. 2. *Pipeline of the study*

Results

The test image used for the study is given in Figure 3(a). After identifying the six faces from Figure 3(a), such face images are resized to 20x20 and are used for classification purpose in the form of three different feature vectors i.e. 400x6, 59x6 and 36x6. As a result, as reported in Table 1, machine learning methods perform poorly as no feature extractor is used and the highest accuracy of 66.7% is obtained only with ANN as shown in Figure 3(b). On the other hand, the feature obtained with the help of LBP underperformed with 33.4% highest accuracy by both KNN and ANN and shown in Figure 3(c). The perfect classification with 100% accuracy is obtained while integrating the HOG and RF approaches as shown in Figure 3(d). From the results, it is clearly evident that raw image (without feature extractor) and LBP work poorly with machine learning methods.

Feature Selection Method	No. of Features	Machine Learning Method	Accuracy (%)
Without Feature Extractor	400	KNN	33.4
		NB	16.7
		DT	33.4
		SVM	33.4
		ANN	66.7
		RF	50.0
LBP	59	KNN	33.4
		NB	16.7
		DT	00.0
		SVM	16.7
		ANN	33.4
		RF	16.7
HOG	36	KNN	33.4
		NB	16.7
		DT	66.7
		SVM	16.7
		ANN	66.7
		RF	100.0

Table 1. *Face recognition by six machine learning methods considering Without Feature Extractor, HOG and LBP features on the testing image of size 20x20*

From the above results, it can be easily seen that feature extraction for face detection plays a vital role and not every feature representation can suit well for each machine learning method. For example, HOG feature extractor performs better than others but the same HOG feature matrix has different outcomes such as 100% in case of RF but around 66.7% in case of DT and ANN which highlights the importance of machine learning method selection for face recognition. Also, a difference in the performances between HOG and LBP features can be noticed, where HOG feature works better in each case. For example, in Table 1, in case of HOG feature matrix along with RF, an accuracy of 100% is obtained while the same classifier with LBP feature matrix representation shows a significant decline in the performance with an accuracy of 16.7%. Therefore, from this study it can be inferred that HOG feature representation performs well than LBP and normal image. Secondly, the feature matrix representation decides which aspect of the data is significant in each class thereby removing the redundant features and easing the

training process for the machine learning methods. However, it should be noted that each representation matrix works differently from others i.e. one feature important to one method maybe redundant for others. Like, from the study it is observed that HOG is a better feature extraction method than the other two. Third, from this study we have noticed that selection of machine learning methods for a feature extractor may provide better or poor results. For instance, from Table 1, HOG with RF produces 100% accuracy but performs relatively poor for other machine learning methods. Thus, HOG with RF is able to recognize faces with 100% accuracy. To summaries, this study provides a pipeline which identifies and recognizes the faces perfectly.

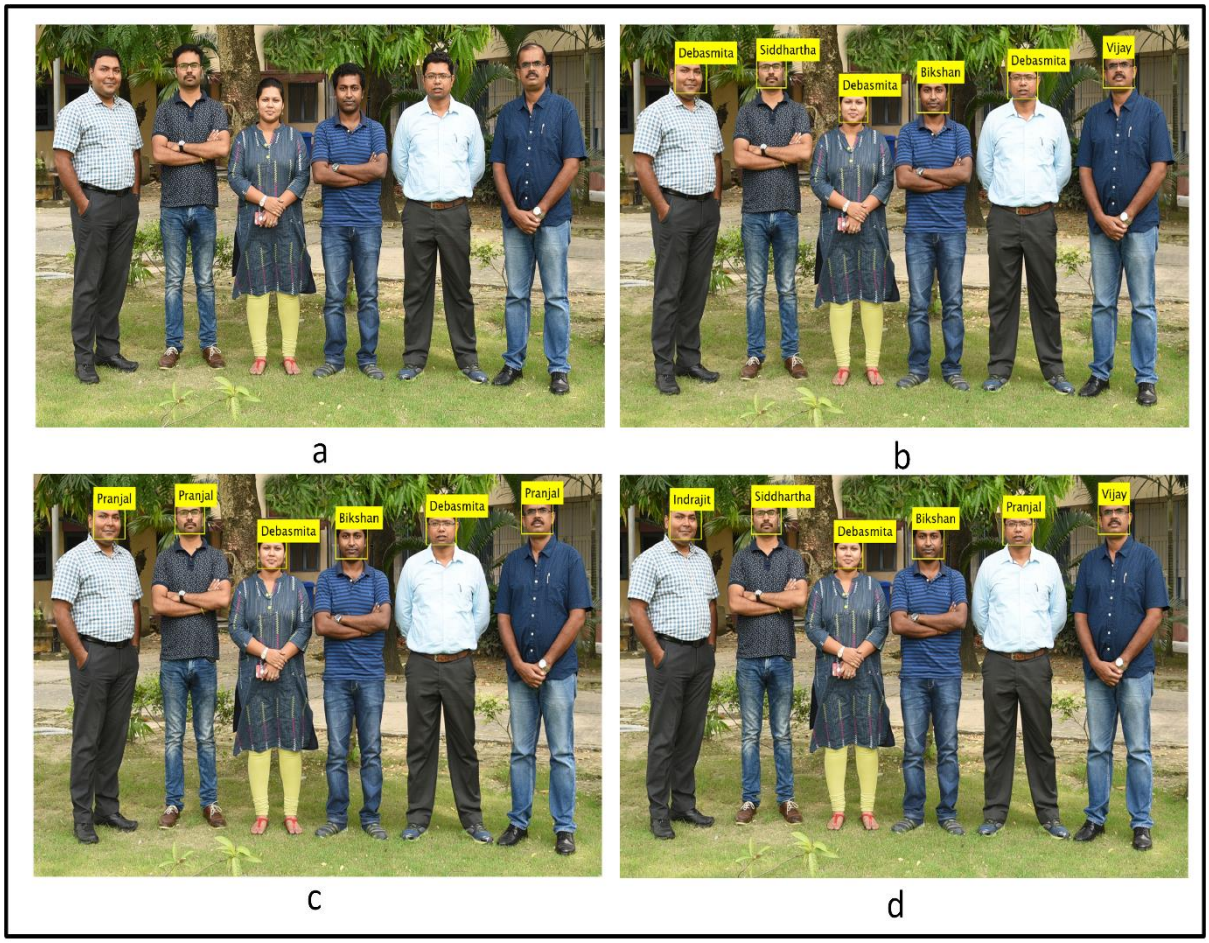

Fig. 3. *(a) original testing image, results of face identification and recognition where (b) shows the best prediction accuracy as 66.7% using ANN without feature extractor, (c) shows the best prediction accuracy as 33.4% using ANN and LBP and (d) shows the best prediction accuracy as 100% using RF and HOG*

Conclusion

In this work, a comparative study between HOG and LBP feature extraction methods and machine learning is carried out for face identification and recognition to identify the important factors that play significant roles in such a system. In this regard, data is created with STTP participants of NITTTR, Kolkata. As a result, six individuals are considered for dataset curation with different characteristics such as face expressions and luminance. Further, from these images face identification is carried out to prepare a face image dataset for training by using commonly used machine learning methods i.e., K-Nearest Neighbour, Naïve Bayes, Decision Tree, Support Vector Machines, Artificial Neural Network and Random Forest. Moreover, this study focuses on image feature extraction with the help of existing methods like histogram oriented gradient and local binary pattern. From the evaluation of the different combination of the two different factors i.e. feature extractor and machine learning, it can be seen that both the factors play significant roles in deciding the

outcome for face identification and recognition. Our study shows that the best accuracy as 100% using RF and HOG for face identification and recognition. Thus, this study provides a pipeline which identifies and recognises the faces perfectly. Therefore, face identification and recognition should be carried out by considering many different parameters to achieve the desired results rather than only working with one single aspect. For future scope of research, we can work on increasing the variability in our image database by considering more different feature representations.

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8 A Case Study to Exhibit Instructional Planning, Design, Execution and Assessment with Measurable Student Learning Outcomes in Outcome-Based Education

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Abstract

OBE archetypal is being implemented as a firm step at engineering institutes in India at the instant. It is measured as a huge jump to advance technical education in India and support students contend with their worldwide equivalents. The various assessment tools for measuring Course Outcomes (COs) and Programme Outcomes (POs) include both summative and formative assessments. The summative assessment includes end and mid-semester examinations with quizzes, and assignments. The formative assessments include innovative teaching methods such as group activities, paper, and poster presentations, mind maps, seminars, role plays, flipped classrooms, and assessing student participation with Mentimeter, Kahoot tools, etc. These all-inclusive instructional design assessment patterns help the course coordinator to measure the attainment of COs and POs and identity individual student learning competency. This work discusses the aforementioned features over a course; to exhibit the instigated approaches practiced using instructional technology tools. Student progression is tracked and observations are positive that there is an improvement in enhancing student's understanding and competency happened with adopted learning methods. Hence, usage of such instruction design methods exhibits that the actual success of the education theory of a programme lies in the effective implementation of OBE practices by both faculty and students.

Keywords:
Outcome-Based Education, Measurable Student Learning Outcomes, course outcomes, programme outcomes, Assessments

Introduction

OBE owns the supremacy to transmute the learning experience of students individually, emboldens them to gain knowledge and be matured with a superior thought process, and be successful in their career. OBE cycle emphasizes a) Planning b) Design and implementation and c) Assess the outcomes. For realistic enactment, OBE is accorded with strategies to design curriculum and deliver content with effective teaching strategies to attract the attention of learners. These factors are enforced towards continuous target-oriented standard assessments particularly to quantify student's engagement in a particular course. Especially OBE cycle cites as two-way feedback between the learners and the teachers. The present work endeavours to demonstrate the working of this cyclic process with a case study by exhibiting instructional planning, design, execution, and assessment with measurable student learning outcomes over a course. India has to turn out to be a countersign associate of Washington accord from June 2014 onwards. The National Board of Accreditation (NBA) accredits the engineering programmes in the country based on OBE. In OBE, the curriculum is organized with verbs using Bloom's taxonomy. The OBE schemes emphasize upon the strong values for noticeable and measurable outcomes from the performance of the students throughout the programme. Moreover, OBEs attention residues on the valuation of outcomes of the programme by maintaining the knowledge, skill, and behaviour that a student is anticipated to accomplish upon the conclusion of a programme.

The case study taken up to exhibit instructional design was with a course DBMS theory and lab courses targeted over the students of II Year II Semester B. Tech CSE for the academic year 2019-20. The presented work divides the instructional design into three divisions. a) Pre-class preparations b) Measurable learning outcomes and improvements with formative assessments c) Measurable learning outcomes and improvements with summative assessments. The first division will exhibit the pre-class preparation done for the students. The first division hosts curriculum design, lesson plan, Google classroom, online lectures, short presentations, online lecture links via Nasscom platform, SVES connect Android mobile app links, and handouts, lecture notes, and course files, with this instructional planning, design, and execution are rolled towards addressing the students.

The second division will exhibit the formative assessment tools used in the classroom such as Google classroom for communication with students, mind maps, technical presentations, crosswords, and interactive quizzes with Google forms, Mentimeter, Kahoot, and Edmodo tools. From these activities students learning outcomes are assessed and measured via an instructional design tool as stated in the second division and exhibited are using the OBE process in form of evaluation sheets and rubrics. Timely feedback towards the improvement of student's performance is measured and recommendations are made to a student for their improvements individually. Further instructional technology tools mentioned in the third division use the results of summative assessment with two mid-semester examinations and end university examination for assessment. These are interpreted as a holistic measurement of students learning outcomes of using OBE because it replicates the all-inclusive instructional design stated in the three divisions.

Literature Review

The authors of [2] in their article carried out a study to understand the impact of assessment in OBE, especially in Indian education, and justified that it is inevitable to take the strategy towards shifting the Indian engineering education as student centric. The work of [1] mainly focus on adoption of OBE implementation especially in Tier-I i.e. autonomous colleges in India. An interesting study conducted by [6] lists all the important asserts in OBE and even makes comparative

study among implementation issues happened in OBE in different countries and identifies commonalties between instructional delivery and student learning outcomes. The work of [5] makes a global report on OBE schemes with qualitative and quantitative assessment with an aim towards building flexible sense methods that is being adopted in various countries and proves the impact is prospected with a continuous improvement in both faculty and students. The authors of [7] recommend a framework to analyze students' performance with value-added courses to attain programme outcomes and even targets as one of an instructional way in minimizing the curriculum gaps. The article by [8] insists a strategy that requires evidence of evaluation to book the quality of education with OBE. They highlight there is no unique technique that ratifies teaching methodology and evaluation to gain POs and it is left to the course coordinator to adopt while designing and developing specified outcomes.

The authors of [9] focus on the positive sides of OBE stating it is now a formal way in education to achieve results at the end which involves different teaching styles, assessments etc. by making a comparative study between modern and traditional education. An interesting survey produced by [10], states OBE is the need of the hour and one of the integral parts of engineering education with a prime sustainable pillar of socio-economic development. The rate of literates towards education in India and abroad are compared and by 2035 India would be more successful in this aspect with the new education policy-2020. A similar work is taken by the authors of [11] which reveals the nature of OBE, its level of impact in student's centric learning and to attain the well-defined measurable outcomes. It also joins the prominence of instructional delivery, appraisals and goals towards outcomes assessment. All these literatures helped the work to move towards a holistic proposal for a course.

Methodology for instructional planning, design and execution

The ideology starts with an environmental scan towards planning the curriculum design to improve students learning and make students employable. This initiative is taken up by the stakeholders to frame the syllabus as a problem centered curriculum design which increases the student's creativity and innovation when learning purposefully and systematically. With all this invincibility the instructors can build a fleet-footed movement and make them more wizardry to elevate to unseen levels.

Title of topic presented as mind map			SQL-commands			
Mind map rubric parameter/marks						
Regd. No.	**Structure (4M)**	**Exploratory (4M)**	**Communication (4M)**	**Connections between sections (4M)**	**Extent of coverage (4M)**	**Total marks (20M)**
18B01A0593	4	4	4	3	3	18
18B01A0598	4	4	4	4	4	20
Overall impression				**Excellent**		

Table 1. *Mind map evaluation sheet.*

Mind map rubric marks / parameters	1	2	3	4
	Poor (40%)	**Average (60%)**	**Good (80%)**	**Very Good (100%)**
Structure	Few ideas radiate out from the center. Not very clear.	Some ideas radiate out from the center but are not suitable for the topic.	Ideas radiate out from the center in a clear picture that involves imagination and creativity.	Ideas provide a complete picture with a high degree of imagination and creativity.
Exploratory	Ideas are not connected from the most complex to simplest.	Some ideas move from the most complex to simplest.	Ideas are arranged in order of importance from the most complex to simplest.	Clear and highly effective indication of a connection between ideas and central image.
Communication	Limited use of keywords. Some images are not applicable.	Keywords are used. Average understanding of the topic.	Good use of keywords and Images connected to the central topic. Good understanding of the topic.	Highly effective use of keywords and images and deep understanding of the topic.
Connections between sections	Little or no use of color, codes, or links to show connections between ideas.	Some effort to use color, codes, or links to show connections between ideas.	Uses color, codes, or links to show connections between ideas.	Effective use of color, codes, or links to make connections between ideas meaningful.
Extent of coverage	Limited or ineffective effort to connect main ideas together.	Good or adequate effort to connect main ideas together.	Effective effort to connect main ideas together.	Highly effective effort to connect main ideas together.

Fig. 1. *Rubric to evaluation mind map.*

First Division: Pre-class preparations

The Database Management Systems (DBMS) theory course surged is self-ruled with the autonomous curriculum syllabus at per with course objectives, course outcomes, program outcomes and with a correlated matrix of both COs and POs, lesson plan, Two e-text books pdf, unit-wise handouts, unit-wise PPTs/PDFs from two prescribed textbooks, unit-wise important questions, unit-wise MCQs, assignment questions with scheduled dates, SQL and PL/SQL programming exercises with solutions. Video lectures URLs citing to Nasscom edcast, which had the biggest contribution from industry and academic experts where listening to video lectures will be a crucial factor that will lead to the progress in the course content. The Vishnu learning app deployed at https:// play.google.com /store /apps/details?id=com.bvrith.svesqbank&hl=en attributes a re-articulation of relationalities of course theories in form of MCQs. Attempting these objective questions possess rapid appraisals in form of feedback, helps them to develop a layered understanding of content. Along with this, a course file is supplanted to manifest all the legitimacy of archives of all exhibits used in instructional planning, design, execution, and assessment. The first division speculates to understand and provide insights of delivery and assessment methods of COs.

Second Division: Measurable learning outcomes and improvement with formative assessments

A smooth and expeditious rollout of the pre-class preparations, with the delivery and assessment methods drafted in to achieve scale, is imperative to help measurable learning outcomes and improvements with formative

and summative assessments navigate the bumps ahead more precisely. In the second division, an independent panel to assess the delivery method on evaluating the achievement of COs makes a potential explosion of formative assessment tools to make opportunities on the anvil. Much for the unfettered access to the instructional design spawned learners to an inconceivable space in terms of Google classroom, forms for communication with students, mind maps, technical presentations, crosswords, and interactive quiz with Mentimeter, Kahoot, and Edmodo tools. From these activities students learning outcomes are assessed and measured via an instructional design tool as stated in the second division using the OBE process in form of evaluation sheets and rubrics. Timely feedback towards the improvement of student's performance is measured and recommendations are made to a student for their improvements individually.

Regd. No.	Title of presentation	Technical presentation: review components					
		Presentation skills (15M)	Knowledge & content (15M)	Selection of topic (5M)	Queries (5M)	Submission of reports (5M)	Total (50M)
18B01A05A1	Types of Joins in SQL	15	15	5	4	5	44
18B01A05A2		11	15	5	4	5	40
18B01A05A3		15	20	5	4	5	49
18B01A05A4		15	15	5	4	5	44
18B01A05A5		11	15	5	4	5	40

Table 2. *Review components in technical presentation*

Review component	Marks	Very poor up to 20%	Poor up to 40%	Average up to 60%	Good up to 80%	Very good up to 100%
Presentation skills	15	Does not look at the audience; read notes or slides. Do not use gestures or movements. No confidence.	Makes infrequent eye contact; reads note or slides most of the time. Uses a few gestures or movements but they do not look natural. No confidence.	Keeps eye contact with the audience most of the time; only glances at notes or slides. Uses a few gestures or movements but they do not look natural. No confidence.	Keeps eye contact with the audience most of the time; only glances at notes or slides. Uses a few gestures or movements but they do not look natural. Show some confidence.	Keeps eye contact with the audience most of the time; only glances at notes or slides. Uses natural gestures and movements but they do not look natural. Look confident.
Knowledge and content	20	Content is inaccurate and information is not present in a logical order. Making it difficult to follow.	Content is questionable and information is not presented in a logical order. Making it difficult to follow.	Content is accurate but the information is not presented in a logical order, making it difficult to follow.	Content is accurate but some information is not presented in a logical order but is still generally easy to follow.	Content is accurate and information is presented in a logical order.
Selection of Topic	5	Not relevant to Specialized Branch.	Relevant to specialized branch but not relevant to the application, analysis. No	Relevant to specialized branch and application but not relevant to the analysis. No	Relevant to specialized branch, application, analysis. No content.	Relevant to specialized branch, application, analysis. Content in topic.
Queries	5	Not respond to questions.	Responding to some of the questions but incorrect.	Responding to all questions but all are incorrect.	Responding to all questions but some of the answers correct.	Responding to all the questions and all the answers correctly.

Fig. 2. *Rubric for technical evaluation*

Regd. No.	Evaluation criteria					
	Level of engagement in class (4M)	Listening questioning & discussing (4M)	Behaviour (4M)	Problem solving (4M)	Team work (4M)	Total (20M)
18B01A0567	4	4	3	4	4	19
18B01A0579	3	4	4	3	4	18
18B01A0584	4	3	4	4	4	19
18B01A0590	3	4	3	3	4	17

Table 3. *Crossword evaluation criteria*

Evaluation criteria/marks	4 Marks	3 Marks	2 Marks	1 Marks
Level of engagement in class	Students proactively contribute to the class by offering ideas and asking questions more than once per class.	Students proactively contribute to the class by offering ideas and asking questions one per class.	Students rarely contribute to the class by offering ideas and asking questions.	Students never contribute to the class by offering ideas and asking questions.
Listening, questions, and discussing	Respectfully-listens discusses and asks questions and helps direct the group in solving problems.	Respectfully-listens discusses and asks questions.	Has trouble listening with respect and takes over discussions without letting other people has a turn.	Does not listen with respect argues with teammates and does not consider other ideas.
Behaviour	Students rarely display disruptive behaviour during class discussions and group activities.	Students rarely display disruptive behaviour during class discussions and group activities.	Students occasionally display disruptive behaviour during class discussions and group activities.	Students almost always display disruptive behaviour during class discussions and group activities.
Problem solving	Actively seeks and suggests solutions to problems.	Improve on solutions suggests by other group members.	Does not offer solutions, but is willing to try solutions suggested by other group members	Does not try to problems or help others solve problems.
Group/teamwork	Works to complete all group goals. Always has a positive attribute about the tasks and work of others. All team members contribute equally. Performed all duties of assigned team roles.	Usually helps to complete group goals. Usually has a positive attribute about the tasks and work of others. Assisted team members in the finished project. Performed nearly all duties of assigned.	Occasionally helps to complete group goals. Sometimes makes fun of the group tasks and work of others. Finished individual tasks but did not assist team members. Performed some duties of assigned team roles.	Does not work well with others and shows no interest in completing group goals. Often makes fun of the work of others and has a negative attitude. Contributed a little to a group effort. Did not perform duties of assigned team role.

Fig. 3. *Rubric for crossword evaluation.*

The first activity taken up in this division is the mind map, and its implementation as mentioned in Table 1, and Fig. 1. The class strength of students is 66, but in interest of space only 2 to 10 students' data is deliberated. To enhance student learning a set of benchmarks are set in summative assessment and certain rubrics and evaluation criteria are used in formative assessments. These sets of benchmarks, rubrics, and evaluation procedures are used to operationalize the learning outcomes of students and guide them for better

prospects of the assessment measures. The activity in which the students participated in the base for data and student's performance is evaluated based on the impact factors, assessment guidelines, and rubrics. It helps us see the effects of our strategies so that we can reinforce what is working or changing, if not appropriate. The measurable attributes mentioned in Fig. 1, each have their significance and identity as structure, exploratory, communication, connections between sections, extent of coverage. The complete cycle of presenting mind maps, assessment criteria, rubric used for evaluation, and feedback to students is prevailed with a good sense and lead more in a liberal approach. Tougher scrutiny is pinned in the form of technical presentation as a formative assignment and is reflected in Table 2. For now, the COs are in a positive direction towards achievement as students deserve credit for a splendid performance in the activity. Table 2 displays the review components of technical presentation and the rubrics shown in Fig. 2 for technical presentation, reflects a solid bench strength to get academic excellence with modest returns. Another revolutionary and progressive confrontation of the formative format of assessment was by adding a creative group activity called crosswords. It welcomes a dialogue that is touted as a framework to elevate student's ingenuity and group work.

The instructional design tool, crosswords activity and rubric towards evaluation of crosswords activity are shown in Table 3, and Fig. 3 respectively. The outcome was so impressive that the new models of reform in education can be used in real life experiments and will drive change and install confidence among the masses. Independent student assessment is formulated via quizzes using eye-catching tools such as Mentimeter and Kahoot. These are used in hoping to shine student's splendid performance outmanoeuvre student's independent skills. The assessment is custom-built and makes students to improve by self, learn better and work harder. Table 4 and Table 5 drifts the questionnaire, responses, scores, and level of impact, and Fig. 4 the rubric used for online quizzes via game based learning and web based polling evaluation and allusions to the evaluation criteria, marks awarded for the activity. Fig. 5 and Fig. 6 make the analogy with systematic reasons of the impact of online quizzes over the students learning outcomes. The level of impact and measuring the students learning and participation is game based learning and web based polling with Kahoot and Mentimeter as shown in Table 6. With all these formative assessment tools the second division instructional tools remain to convince students that it deserves to displace the knowledge purely at the top. Those measurable outcomes in OBE are backed by history and enjoy incumbency, attract the best multitudes of students with better education, and will congruence improvement valued by society. Transforming from second division to third division of student's evaluation is reoriented with tougher scrutiny in the form of summative assessments I and II as mid-term examinations and end university examinations.

Rating scale in percentages	**Needs improvement**	**satisfactory**	**Good**	**Excellent**
Marks/level	**1**	**2**	**3**	**4**
%	**<40**	**>=40 & <80**	**>=80 & <90**	**>=90 & <100**
Justification	Major issues in understanding the key issues. Lacks convincing support for ideas.	Summary show some misunderstanding of major points. Needs analyses and major alternative points of view.	Good understanding of the material. Identifies the salient arguments. Develops consistently strong support for main ideas.	Demonstrates an excellent understanding of the material, well synthesized accurately interprets evidence, statements, graphics, questions, etc. Support for main ideas is uniquely accomplished.

Fig. 4. *Rubric for online quizzes via game based learning and web based polling.*

Regd. No.	Scores	% of marks	Impact level	Feedback
18B01A0564	1934	40-80%	2	Satisfactory
18B01A0569	2615	80-90%	3	Good
18B01A0572	2186	80-90%	3	Good
18B01A0577	3117	90%-100%	4	Excellent

Table 4. *Scores tabularized with levels of impact and feedback Mentimeter web based polling.*

Regd. No.	Scores	Total marks	Feedback
18B01A0561	4507	5	Good
18B01A0571	2898	3	Needs Improvement
18B01A0572	3509	4	Satisfactory
18B01A0577	7431	9	Excellent

Table 5. *Scores tabularized with levels of impact and feedback Kahoot game based learning.*

Level of impact	Rubric to measure the impact of learning	
Low (1)	Very light or impact is relatively less	Need feedback for student learning or improvements
Medium (2)	Average, or slight impact on achievement	Neutral effect
High (3)	High or huge impact on achievement	Positive to student learning outcomes
Very High (4)	Excellent, Demonstrates full knowledge with explanation, elaboration	Always positive to student learning outcomes.

Table 6*. Rubric to measure the impact of learning.*

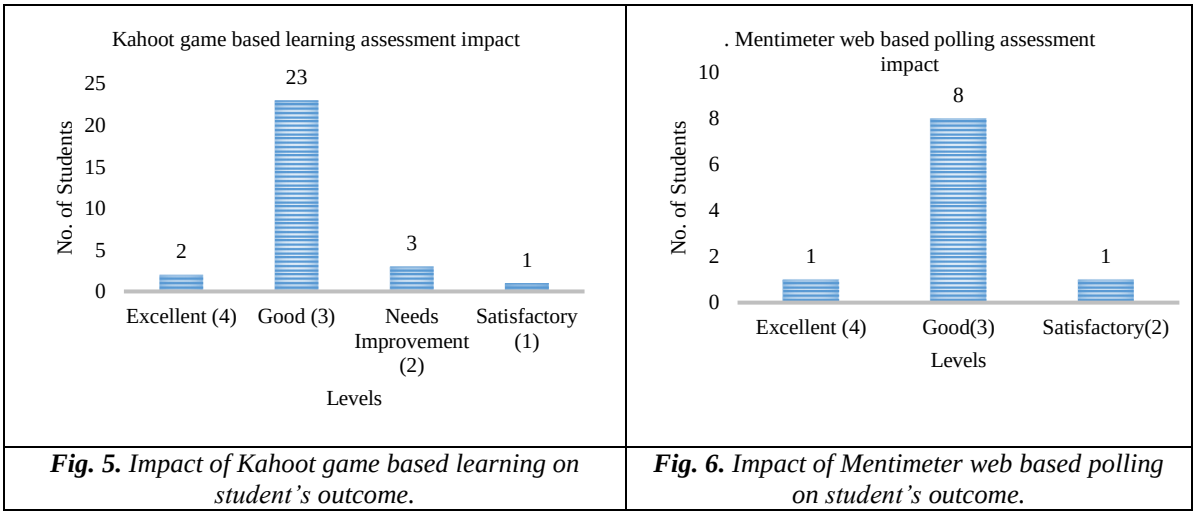

Fig. 5. *Impact of Kahoot game based learning on student's outcome.*

Fig. 6. *Impact of Mentimeter web based polling on student's outcome.*

Third Division: Measurable learning outcomes and improvement with summative assessments

The third division is assumed as the ultimate driver of quality in education and is a desire within the student. It is fairly challenging, and for them, a reasonable education from a college adopting OBE serves well as it is tied strongly to career prospects of students at the highest quality education. Table 6 denotes a rubric to measure the impact of learning that occurred in the first and second divisions as shown in the form of 4 levels. Table 7 shows the DBMS course Summative Assessment (SA-I) marks with students' segmentation into levels and Fig.7 displays the learning impact on students of SA-I.

The learning outcomes illustrated in both Table 7 and Fig. 7 make a gaining resilience that the purpose of using strategic congruence of formative assessments tools produces effective results and COs mentioned are exhibiting initiation into a process that yields a tangible long term value for OBE.

The learning is so effective that the students mentioned in level 2 and level 3 are very high when compared to level 1. Similarly, a remarkable observation to be made is the class average with 24.16 which falls in the optimal position as 80% of students are thriving with a positive attitude and creating confidence as an acknowledgment to the teacher that learning is happening in the classroom and instructional delivery is reaching to the students. Table 8 states the DBMS SA-II marks with student's segmentation and Fig. 8 presents the learning impact on students of SA-II. Table 8 boons with a menacing rise and aggressive behaviour exhibited by students in level 2, level 3, and level 4 when compared to similar levels in Table 7.

Similar learning impact is logged in Fig. 8 where the conversion of students from level 2 to level 3 happens with 38% more, and level 3 to level 4 happens with 24% more. All these are practical in student learning outcomes hence this justification can be winning a wider support to OBE theories, that the new kink provides a more positive focus and motivation to the grouping. Lastly, to verify whether the skills gained from the course are driven by student aspirations, a confrontation is imparted with the end examination. The Student segmentation in both DBMS theory and laboratory courses is showcased in Fig. 9 and Fig. 10.

Impact	B. Tech. II CSE - B (2018-2022 Batch) - DBMS SA-I Marks			
	< 18 Marks	**18-24 Marks**	**25-27 Marks**	**28-30 Marks**
	<60%	**60%-80%**	**80%-90%**	**90%-100%**
	Low (1)	**Medium (2)**	**High (3)**	**Very High (4)**
Number of students	0	42	21	3
Total number of students	66			
Minimum marks secured	19			
Maximum marks secured	28			
Class average marks of SA-I (30M)	24.16			

Table 7. *DBMS SA-I marks with students' segmentation.*

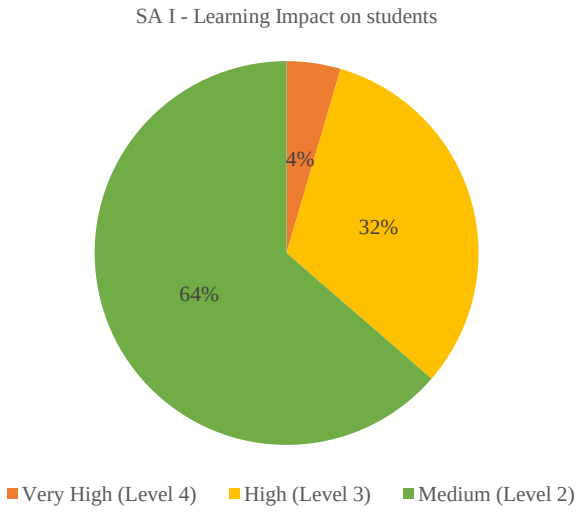

Fig. 7. *SA-I marks – Learning impact on students*

B. Tech. II CSE - B (2018-2022 Batch) - DBMS SA-II Marks				
Impact	**< 18 Marks**	**18-24 Marks**	**25-27 Marks**	**28-30 Marks**
	<60%	**60%-80%**	**80%-90%**	**90%-100%**
	Low (1)	**Medium (2)**	**High (3)**	**Very High (4)**
Number of students	0	12	41	12
Total number of students			66	
Minimum marks secured			19	
Maximum marks secured			30	
Class average marks of SA-II (30M)			28.01	

Table 8. *DBMS SA-II marks with students' segmentation.*

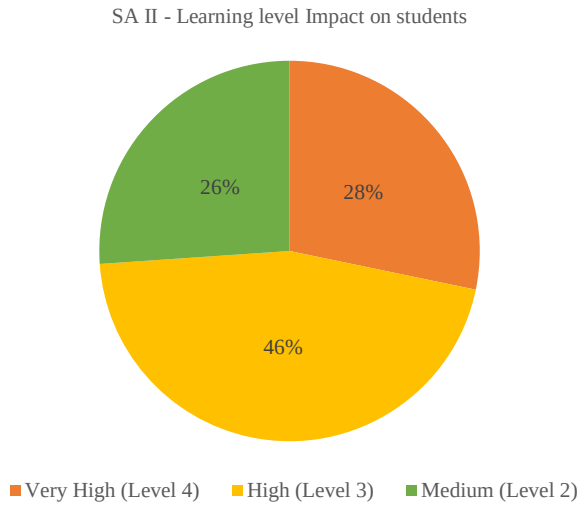

Fig. 8. *SA-II marks – Learning impact on students*

Marks range for theory course (Max-100)	**Marks range for laboratory course (Max-75)**	**Letter grade**	**Level**	**Grade point**
>= 90	>=67	O	Outstanding	10
>= 80 & < 90	>=60 & < 67	S	Excellent	9
>= 70 & <80	>=52 & < 60	A	Very good	8
>= 60 & <70	>=45 & < 52	B	Good	7
>=50 & < 60	>=37 & < 45	C	Fair	6
>=40 & < 50	>=30 & < 37	D	Satisfactory	5
<40	< 30	F	Fail	0
			Absent	0

Table 9. *Rubric of end examination grading system for both theory and laboratory courses.*

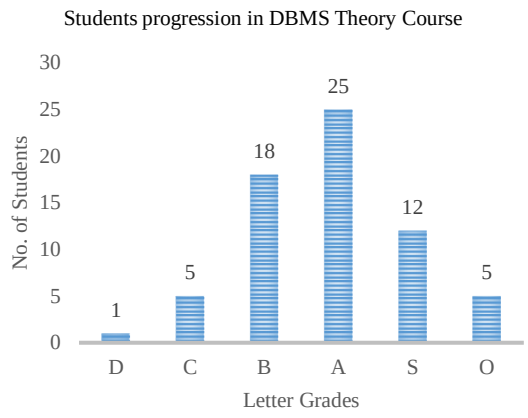

Fig. 9. *Students progression in DBMS Theory Course*

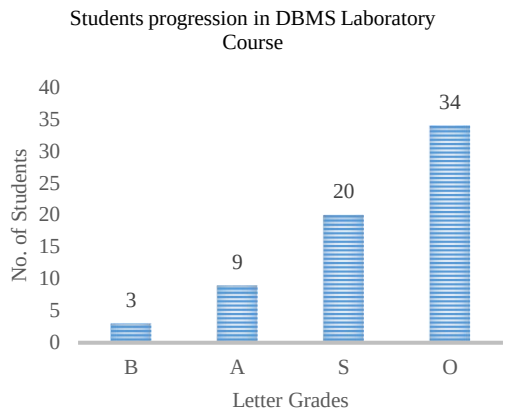

Fig. 10. *Students progression in DBMS Laboratory Course*

The rubric adopted in the end examination to measure the students learning outcome is with a letter grade and grade point to be awarded to the student in each course based on student performance as per the grading system given in Table 9. The exam was taken up by a class of 66 students, which is revealed a critical aspect pertaining from Fig. 9 and Fig. 10 that students have made effort tapping into their huge potential. Students' progression in DBMS theory course replicates similarity to the normal or Gaussian distribution as the spread of student's grades is in a continuous probability distribution [3], [4].

The result of the analysis is generally consistent as it identifies the weaknesses of new engineering students from batch to batch and guides them towards significant perceptions of outstanding achievement. Besides this, the student's progression in the DBMS laboratory course has a massive scale which shows the improvement in quality towards their learning in the course. The numbers of students in the outstanding and excellent segment are claiming more for their favourable response to the course threefold component. A similar win-win situation is being claimed as we can observe that massive students are harboured for moving from good to very good letter point grade when compared to outcomes in the third division. The study has also helped underline the fact that the approaches adopted in form of formative and summative have many adverse implications on the students learning outcomes.

The findings confirmed that a measurement and evaluation procedure is critical in safeguarding the student learning interest in the OBE environment. The instructional design and assessment techniques and tools help co-faculty members and students to understand that the system is resistant to change and always there is a chance to do a critical self-assessment, perhaps as the most important reforms revolve around the engineering education system. The impact of learning is the primary factor influencing student achievement as a potential outcome. Reflecting on teaching strategies is one of the most powerful methods that teachers can use to empower the students.

Conclusion

This paper articulates the instructional planning, design, execution, and assessment with measurable student learning outcomes in OBE in a three-fold approach. The case study uses the courses DBMS theory which was taught to II Year B. Tech CSE. The first fold uses Google classroom for instructional planning and design and to deploy all learning material from time to time. The second fold uses various internal assessment tools such as mind maps, technical presentations, crosswords, and quiz with Mentimeter and Kahoot instruction to assess and improve student learning capacities in form of formative assessment. The third fold uses summative assessment tools such as mid and end examinations as a lynchpin to understanding the holistic student capability of learning in the course.

As teachers, we like to monitor our students' progress in the courses to provide ongoing feedback so that students will improve their learning and also improve our teaching capability as per trends in need. To make this possible we believe that OBE will help us as an inclusive edge between the students and faculty in the organization. As OBE is a student-centric learning model it helps us to plan the course delivery and assessment with the endpoint in mind. The potential next step is to extend the instructional design approach used in this case, to study the other courses which we teach. Also, to migrating the study to a platform that is institutionalizing OBE practices, by achieving limpidity, heightening data inputs, regulating totalling of attainments, sequestering areas for improvements, drifts from large bygone data from batches, and engendering report promptly.

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9 Application of OBE approach for Thermodynamics course in order to improve the overall teaching-learning practice

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Abstract

Gaining importance of OBE has made teachers move towards preparing outcomes with regard to the courses they deal with. Earlier works could not provide a better way of formulating the course outcomes and their appropriateness. In this work, course like 'Engineering Thermodynamics' related to Mechanical Engineering program is used to understand the concepts to be taught, which is covered in most of the institutes or universities in India. Course outcomes are prepared, keeping in view, the syllabus followed in any given semester. Appropriate action verbs are suggested, based on the contents of the topics associated with different units of the course. Comparison is done with the reference bloom's taxonomy table with regard to the abilities acquainted. Also, the appropriateness of the coverage of respective course outcomes for the suitable program is discussed. Suitable assessment techniques are identified and the coverage of COs in each process is presented in a detailed way. Analysis is done to provide a mechanism to the instructors in the aspect of outcomes valuation and ways of doing the same accurately are appraised. Aspect of continuous quality improvement for the selected course is also presented. Thus, the present work paves the way for the teaching community in adapting the OBE approach suitably, in order to meet the vision of the institute through the outcomes of courses and programs.

Keywords: OBE, Course outcomes, Thermodynamics, Action verbs.

Introduction

Faculty and students are the main stake holders of any technological institute. Faculty must be engaged in efficient teaching and the students must be engaged in effective learning. Then only, there is a chance of teaching-learning process to be at its best. Till recently, class-room instruction has been more concentrated towards teachers' oriented with the only objective of delivering lectures aiming completion of the syllabus. Increased demand for quality output has made the teaching community look towards 'Outcome Based Education' (OBE). OBE is more outcome oriented, which takes care of students' aspect with what they exactly gain at the end of a lecture or a course or a program. In this context,

approach of OBE is gaining prominence in institutes and teachers community is in the process of understanding the abilities expected at the end of specific period. In such scenario, faculty of several technical and non-technical institutes in various disciplines are expected to prepare outcomes for their courses.

To make this materialize, there should be proper lecture plan, instructional material and assessment procedure, adapted by the faculty. Preparation of lecture plan involves the preparation of intended learning outcomes expected from that particular lecture and all such lectures cumulatively will lead to the completion of the course in a given semester. This would further lead to achievement of certain Course Outcomes (COs). Outcomes are the abilities expected from the students or learner at the end of the course or a program. The outcomes of a program are achieved through various courses that cover the course outcomes, which are prepared based on the syllabus covered in different units. The maximum number of COs can be 6, as per the norms of National Board of Accreditation in India and elsewhere also the number may be similar. Suggestively, the action verbs have been provided by Bloom's taxonomy table. Any under graduate engineering program may have 45-50 courses. The outcomes of the program are achieved through these COs. The number of courses may vary depending on the program. Evidently, during the designing of the curriculum, it might be ensured that the program level outcomes of the corresponding one are taken care. As such program level outcomes are designed by the respective associations or governing bodies for the implementation of uniform pattern of programs in their respective country or territory, the onus on faculty is to prepare COs only and map them against them to ensure OBE approach is properly taken care for better implementation of the teaching-learning process.

Bloom [1] has suggested the taxonomy of educational objectives, while classifying the educational goals. The objectives were of different levels and provided the teaching community a better way writing the same with regard to their class room teaching. They are of different levels and even now, the same set is followed. Exactly two decades back, the set was revised a little, keeping in view the changing practices in teaching-learning process [2]. In the modified one, the importance of measurability was considered and re-framed accordingly. Later, Cervai et al. [3] discussed about the assessment of learning outcomes, applicable for vocational education. Also, a little was discussed by Coates [4] and Bethany et al. [5] recently. The studies were on assessment and with regards to the objectives of under graduate courses. But, none gave clear idea about the ways of writing the learning outcomes for a particular course of either graduate or under graduate level and the ways of assessing the same. In this context, present work finds significance, as it deals with the way of preparing COs and identifying their attainment levels.

Methodology

In this work, course like 'Engineering Thermodynamics' is used to understand the concepts to be taught, following a standard syllabus, which is covered in most of the institutes in India. The syllabus of the course 'Engineering Thermodynamics' is taken from the model curriculum of Under Graduate engineering program for Mechanical Engineering discipline. The syllabus for a particular semester consists of about five units. Then, based on the contents of each unit, appropriate action verbs are chosen. The selected action verbs are then compared with the learning abilities of the student, suggested by the Bloom's taxonomy table. Then, assessment of COs is discussed for the selected course, offered in NITTTR Kolkata. Appropriate weightage for both the internal and external examinations is given. In order to see the aspect of continuous quality improvement, COs obtained for the last three years are compared. The present methodology is not based on any assumptions and has not considered any approximations. The analysis is done, considering the actual marks attained by the fixed set of students in chosen institute. The calculations refer to real time analysis, using simple methodology required for any such similar courses.

Results and Discussion

In this section, the syllabus of the course 'Engineering Thermodynamics' is studied thoroughly with the idea of choosing appropriate action verbs. Initially, the COs are prepared based on the syllabus and relevance or approach for finalizing the same is discussed. Comparison with the reference set of action verbs or abilities of learning from the taxonomy table is done. Assessment procedure or ways of valuation of COs is discussed. The Overall CO attainment is calculated, based on the actual marks attained by the chosen set of students in internal and external examinations. In the end, attainment of CO for the last three semester marks for the same course offered by the same faculty at NITTTR Kolkata is compared. The tendency of outcomes is studied and appropriate actions to be taken are identified.

Unit-wise syllabus and their relevance with program outcomes

The syllabus for the course is covered in five number of units. First unit covers the fundamental aspects of thermodynamics. It discusses the basic concepts like system, surroundings, types of systems, work and heat. Most of the things are about gaining conceptual knowledge. The knowledge thus gained is related to the basic knowledge at the end of the under graduate program. Second unit covers the law of thermodynamics. First and second laws of thermodynamics are discussed with examples. It also discusses their importance and necessity of defining the same, which are about attaining procedural knowledge. The understanding thus gained is related to the application aspects at the end of the program. Third unit covers the importance of entropy. The definition and importance aspect of losses and role of entropy in various thermodynamics systems is discussed. This is related to the achieving of conceptual knowledge. The corresponding program level outcome can be related to the basic knowledge only. Fourth unit covers the analysis of various gas and vapour power cycles. This is gaining procedural knowledge and comparing the same for different applications. The equivalent program level outcome is related to the application of modern tools or achieving designs or complex solutions. The fifth unit covers the aspect of fuels and combustion. It is about fundamental knowledge related to different fuels and their characteristics. This is related to gaining conceptual knowledge. The outcome is related to the basic, environmental and sustainability knowledge aspects in case of the suitable program, i.e. Mechanical Engineering.

Selection of appropriate action verbs

In this section, selection of appropriate action verbs for the syllabus discussed in the previous section is detailed. The first unit deals with basics of thermodynamics. The ability of understanding is achieved. 'Appreciate' or 'Understand' seem to the correct action verbs. Aptly, 'Appreciate' is used. Second unit covers the principles and laws of thermodynamics. They are applied to various thermal systems. The ability of applying the knowledge is accomplished. Hence 'Apply' seems to be the correct action verb. Third unit covers the significance of entropy. 'Recognize' or 'Understand' seem to the correct action verbs. Therefore, more relevantly 'Recognize' is used. Fourth unit covers the investigation of several gas and vapour power sequences. The ability of analyzing is achieved. Fittingly, 'Analyze' seems to be the correct action verb. Fifth unit covers the discussion on various fuels and combustion characteristics. The ability of understanding is achieved. Appropriately, 'Discover' seems to be the correct action verb. Table 1 shows the course outcomes along with the syllabus in terms of all the units.

Chapters or Units	On successful completion of the course, the students will be able to:
Chapter 1: Basics of Thermodynamics	CO1: Appreciate the fundamentals of Thermodynamics.
Chapter 2: Laws of Thermodynamics	CO2: Apply the laws of thermodynamics.
Chapter 3: Entropy	CO3: Recognize the concept of entropy.
Chapter 4: Gas and vapour power cycles	CO4: Analyze gas and vapour power cycles.
Chapter 5: Fuels and combustion	CO5: Discover various fuels and combustion characteristics.

Table 1. *Course outcomes*

Comparison with Bloom's taxonomy and Assessment processes

Bloom [1] produced a classification of quantifiable verbs to help the faculty to define and categorize noticeable skills and abilities. The levels are based on the actions pertaining to the cognitive activity. Simply, these are the levels of learning displayed by the student, when any faculty teaches something in the class. The levels spread from remembering to creation of something new, pertaining to the technology being studied. In Table 2, the comparison of selected verbs for thermodynamics is done with that of taxonomy table. The levels covered in thermodynamics course are of understanding, applying and analysing of the Bloom's taxonomy table. While setting the question papers for internal examinations like class tests or assignments, it is ensured that a precise and appropriate way is followed. The first internal examination, i.e. class test 1 is conducted, considering CO1 and CO2. The questions rely on testing the student's abilities with regard to these two outcomes. Equal distribution is followed as the weightage is according to the same. The second internal examination is assignment, which is based on CO3. The assignment is based on a topic; which students would study at home in a given span of time. Students are expected to make the presentation related to that in the class; assessment is done, considering the ability gained in understanding and studying the subject. The third and the last internal examination, i.e. class test 2 is conducted, considering CO4 and CO5 for the course chosen. In this case also, equal weightage could be possible, because of equal distribution of the syllabus. Thus it is ensured that all the COs are taken care, while framing the questions and thereby the concerned abilities from the students in the internal examinations. Same is expected to be covered in external examinations, as question papers are set by external agencies, considering the weightage and lecture hours, associated with each unit. This is ensured through regulations provided to paper setters to cover the syllabus appropriately, while setting the question papers. The depiction of the same is presented in Fig. 1.

Syllabus covered	The knowledge dimension	Cognitive ability	Appropriate verb from Bloom's taxonomy	Suitable verb chosen
Basics of Thermodynamics	Conceptual knowledge	Understanding	Understand	Appreciate
Laws of Thermodynamics	Procedural knowledge	Apply	Apply	Apply
Entropy	Conceptual knowledge	Understanding	Understand	Recognize
Gas and vapour power cycles	Procedural knowledge	Analyzing	Analyze	Analyze
Fuels and combustion	Conceptual knowledge	Understanding	Understand	Discover

Table 2. *Comparison of the selected verbs*

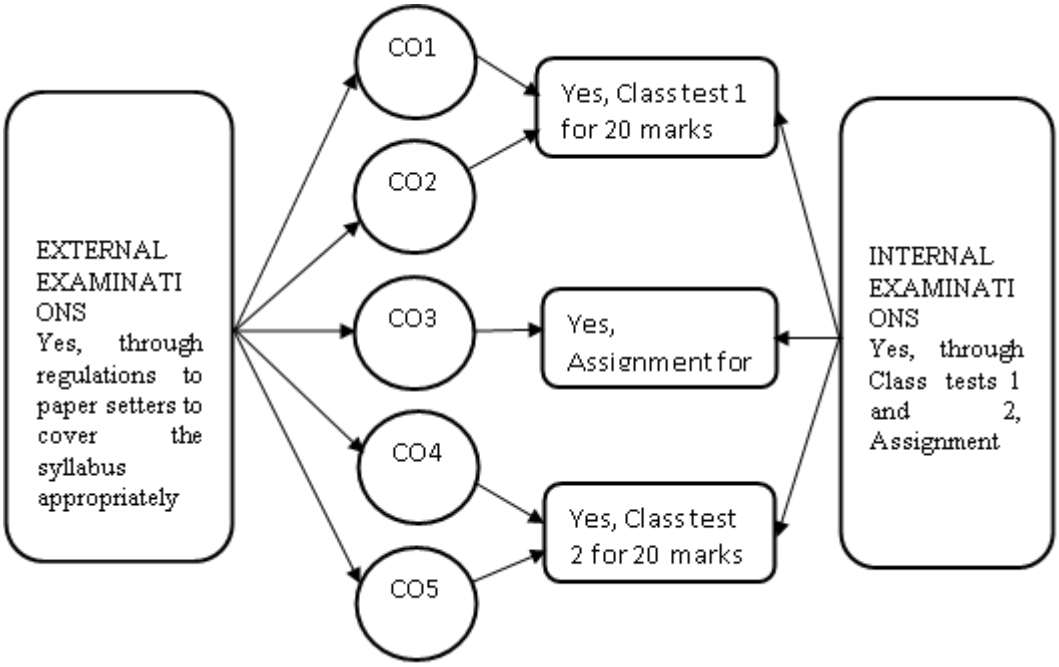

Fig. 1. *Coverage of COs in internal and external examinations.*

CO Attainment

Calculation of the attainment of outcomes is significant in applying OBE approach to various programs and courses. CO assessment involves internal and external examinations as shown in Fig.2. The internal examinations can include class tests, assignments and quizzes. Here, they are referred as Internal I, Internal II and Internal III. The external examinations can have only semester end examinations. For the chosen program, the weightage of internal examinations is 30% and the weightage of external examinations is 70%. Finally, CO attainment is calculated by multiplying the weightage with the level obtained, considering the marks achieved by students with regard to the two examinations, i.e. $0.3 * L_1 + 0.7 * L_2$.

Where, L_1 is the level obtained by the students with regard to the internal examinations and L2 is the level obtained by the students with regard to the external examinations.

The set of regulations used to decide the level for internal examinations in this study is,

Level 1: If 60% of the students score over 40% of the marks.

Level 2: If 70% of the students score over 40% of the marks.

Level 3: If 80% of the students score over 40% of the marks.

The set of regulations used to decide the level for external examinations in this study is,

Level 1: If 60% of the students score over the average mark of the course.

Level 2: If 70% of the students score over the average mark of the course.

Level 3: If 80% of the students score over the average mark of the course.

The guidelines for the selection of levels for all the courses of a program are decided by the highest academic authority, i.e. academic council or board of studies. For the present course and program, i.e. academic council, which meets once or twice in a year to finalize such regulations and other academic aspects. In the present example, the marks attained by the students are collected and verified with 40% mark for internal examinations and verified with the average mark of the course for external examinations. Table 3 shows the marks obtained by students in both internal and external examinations and the overall CO attainment. Students are at level 3 with regard to the internal examinations. Students are at level 1 with regard to the external

examinations. The overall CO attained for thermodynamics in the recent semester is found to be 1.9.

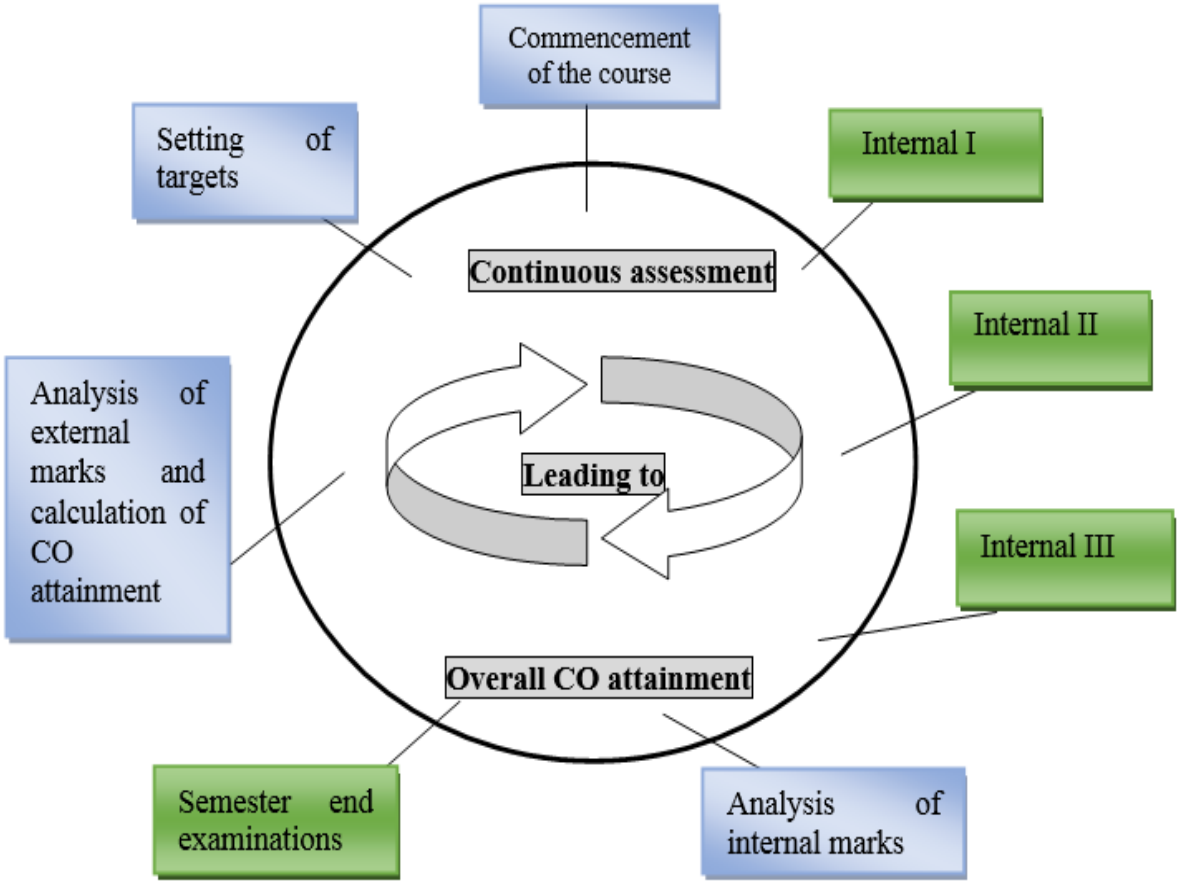

Fig.2. *Continuous assessment and attainment of CO.*

Type of examination	Total number of students	Marks obtained by the students	Level attained with reason	Respective attainment	Overall CO attainment
Internal examinations (Maximum of 30 marks)	18	24, 18, 22, 9, 22, 23, 21, 20, 28, 19, 16, 18, 10, 14, 22, 9, 24, 21	3 (As 15 out of 18 students, i.e. 83% could score over 40% marks in the course).	0.3*3 = 0.9 (L_1)	0.3 *L_1 + 0.7 *L_2 0.9 + 1 = 1.9
External examinations (Maximum of 70 marks and University average:63)	18	74, 68, 72, 59, 62, 73, 81, 60, 88, 49, 76, 68, 40, 64, 72, 64, 91,45	1 (As 12 out of 18 students, i.e. 66% only could score over the average mark of 63 in the course).	0.7*1 = 1 (L_2)	

Table 3. *Marks obtained by students and the overall CO attainment*

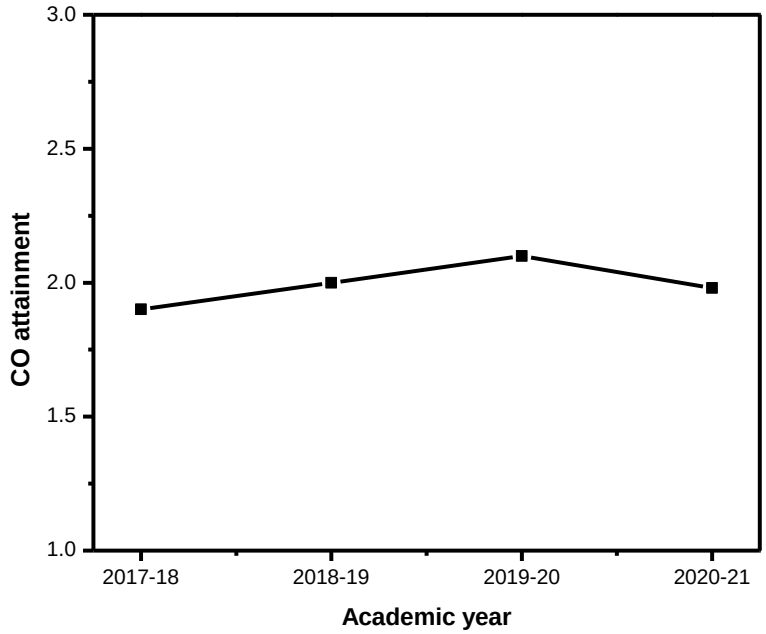

Fig.3. *Comparison of CO attainment.*

Analysis of COs for the last three years

In this section, CO attainment levels are analyzed, considering the marks obtained by of 'Thermodynamics' course taken by the students of NITTTR Kolkata for the last three years, i.e. the instances of the taking the same course previously. The variation of the level of attainment is within a span of 10%, i.e. the levels attained by the students has not been varying very randomly, as shown in Fig.3. It is clear that the attainment is good, considering the pattern. But, the level has got a dip in the latest year or when the course is offered recently. For the set of faculty and institute considered here, the reason can be either due to decreased level of students' competency or increased cut-off mark in the entrance examination. In the point of view of the instructor, further analysis can be done and stress can be given attaining the outcomes appropriately, based on the internal examinations. Clearly, if CO1/ CO3 / CO5 are not attained, the stress should be given on teaching the fundamental aspects of the course. It is on solving problems in the class and giving more examples for tutorial classes. Evidently, if CO2/ CO4 are not attained, the concentration should be given on applying principles or laws or cycles. Further, the target for that particular course can be increased and ensured that continuous quality improvement is achieved, as desired by the program coordinators or heads of the departments.

Conclusion

In this work, the approach of OBE is applied to a course like 'Engineering Thermodynamics' related to mechanical engineering program. Effort is made to understand the concept of the same and in framing the corresponding course outcomes. COs for this course are covering the dimensions of conceptual and procedural knowledge. The learning levels are of understanding, applying and analyzing. Comparison is made with the base Bloom's taxonomy table, to appreciate the selection of action verbs, based on the syllabus covered in the course considered. Later, appropriate process of CO attainment is laid down and discussed. After analysing the same, attainment achieved in the course is calculated. CO attainment for the current set of marks obtained by the students is 1.9. The CO attainment calculated for the present set of students seem to be increasing with more effort to be given on CO1 and CO2 in the days to come. Also, the attainment of the same course offered by the same faculty are plotted. It is observed that the attainment is steady. However, there has been a down trend for the recent semester, which shows that appropriate actions are to be taken by the faculty concerned in order to be in

process of continuous quality improvement, as expected by the higher authorities concerned or as desired by external certification processes. Thus, the present work studies the appropriateness of OBE and application of the same to courses offered in engineering programs.

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10 Real time analysis of CO and PO attainment and their significance in case of a post graduate engineering program

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Abstract

Attainment of Course Outcomes (COs) leads to the attainment of Program Outcomes (POs) of the program concerned. Appropriate attainment and related assessment plays crucial role in achieving the desired teaching-learning processes. Earlier works described few methods to calculate the attainment of such outcomes with more limitations on the analysis. Eventually, the processes were not that helpful in establishing assessment aspects and deciding the future course of action for the program. In this work, the assessment of outcomes is dealt in a systematic manner and the real time analysis of a post graduate engineering program is done. The program under study has 20 courses and the number of students is 14. Marks obtained by the students for all the courses of the program are collected and analysed. Class average is calculated and is taken as reference, as this program is offered only in the institute under study, affiliated to the concerned University. Levels are decided by comparing the class average with the number of students crossing the same. Based on the CO-PO mapping, the CO attainments thus obtained are used to calculate the attainment of PO1 to PO6. From CO analysis, it is found that even though the class average is more, the levels attained are low in some courses. The pattern of assessment and teaching-learning processes seem to be good, only in limited number of courses. Attainment is low in case of PO2. Even though the attainment of PO1, PO4 and PO5 is slightly better, attention must be given to improve in the following year. Some useful findings are also obtained for the concerned program, which need to be looked into, to avoid poor attainment aspects. Study entrusts the teaching community to be cautious about assessment and marks are to be awarded based on the designed principles of valuation.

Keywords: Program Outcomes (POs), Course Outcomes (COs), CO attainment, PO attainment, Assessment.

Introduction

For the long run of the institute or meeting the vision of the institute, there should be better input in the form of admissions and output in the form of placements, higher studies and entrepreneurship. For better intake and placements of the outgoing students, the teaching-learning processes should be at their level best. Teaching-learning processes mainly deal with preparation of lecture plan and course file, in the perspective of the faculty. Apart from them, conducting examinations and maintaining the quality of question papers used

and ways of assessment also play crucial role. In addition, conducting class committee meetings, faculty meetings and stake holders' meetings also play the part in the perspective of the program. Using all these methods, if COs are achieved, they will directly lead to the meeting of the vision of the institute as shown in Fig.1. The linkage and the other aspects of any program are clearly shown. As depicted, vision of any engineering establishment is to become a reputed engineering institute imparting technical education in emerging areas of engineering in a certain region. In order to meet the vision, mission statements are made. These statements deal with how the vision is achieved. It may consist of faculty competency, state of the art lab facilities and maintain the overall teaching-learning environment conducive for learning. Program Educational Objectives (PEOs) define why the students join in a particular program. POs are the abilities expected at the end of the program. COs are the abilities expected at the end of the course. First, through better teaching–learning and proper assessment, COs are achieved. If it is implemented appropriately for all the courses, POs are achieved. This will lead to the fulfillment of the PEOs and thereby accomplishing the mission of the department and thus that of the institute. Finally, the vision of the department and the institute are met. It is clear that the basis of all is the way how teaching is done in the class and how assessment is done in the course.

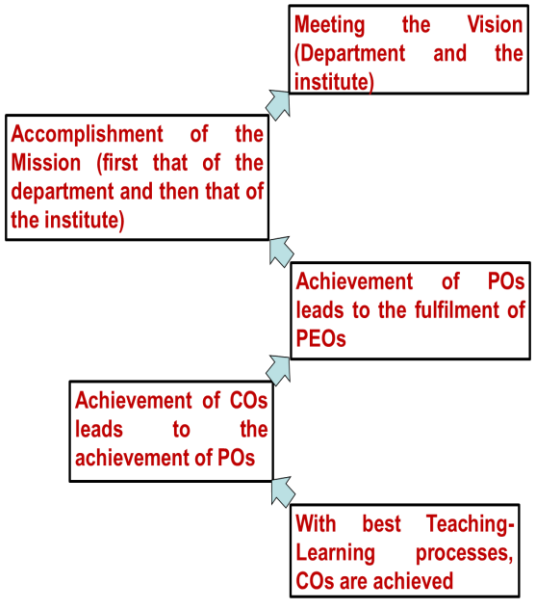

Fig.1. *Relevance of classroom teaching-learning with other components of OBE.*

The main component in this scenario is attainment of COs and POs. The attainment of all the COs meticulously ensures POs are achieved properly. Earlier, Bloom [1] has suggested the taxonomy of educational goals, which were of different levels and provided the teaching community, a better way writing the same with regard to their courses. They are of diverse levels and even now, the same set is used. Later, the assessment of learning outcomes was discussed by Ramona and Camelia [2]. It involved a little discussion about various tools that are used in the assessment of outcomes. There have been good number of works carried out in the outcomes assessment related to clinical trials. It is not relevant to the present work and hence not mentioned here. Keeping in mind, the usefulness of outcome based education and its increasing application in higher education, Memon and Harb [3] were involved in developing an assessment process for an electrical engineering education program at a UAE University. Naqvi et al. [4] proposed a set of course learning outcomes that may be related to any engineering problem with regard to the final year project in undergraduate engineering programs. Jaurena and Softic [5] dealt with a learning outcome approach using web tools and their limitations as well as strengths. Interestingly, Westlake et al. [6] identified that educational attainment is associated with unconditional helping behaviour, which may not be correct in the present scenario of technical education. This study has delivered fresh understanding into social unselfish behaviour and has covered that this is liable on background issues. Thus, earlier works discussed about relevance of outcomes and their applications in various environments. But, none of these works dealt with the actual way of assessing COs and POs. Also, none analysed the outcome of attainment calculations and the impact of assessment and future course of action, suitable for any engineering program. In this context, present work finds its significance, as it deals with the way of calculating CO and PO attainment and the vital role of appropriate assessment.

Methodology applied

In this work, the Post Graduate (PG) program of M. Tech in Manufacturing Technology of NITTTR Kolkata, which is the parent institute

of the author, is chosen for the analysis, in order to give emphasis on the impact of assessment in the present day teaching-learning processes. Study conducted is a real time analysis, i.e. actual marks obtained by the students of 2019-21 batch are considered. The PG program under study has 20 courses spread in four semesters and the actual number of students of that particular batch is 14. Marks obtained by the students at the end of the semester for all the courses of the program are collected and CO attainment is calculated. Marks obtained by the students in the internal examinations are submitted to the affiliated University and grades are given by them, considering the marks obtained in both (internal and external examinations). These grades are converted to appropriate percentage of marks. Class average is calculated and is taken as reference, as the select program is offered only in the institute under study. Guidelines for deciding the levels of attainment are decided by the Academic Council of the institute and are specified in Table 1. Based on their recommendations, levels are decided by comparing the class average with the number of students surpassing the same. The CO attainments obtained are used to calculate the overall PO attainment, based on the CO-PO mapping approved by the faculty of the program. For PG programs, it is based on course-wise attainment only [7], which simplified the overall process.

Attainment levels	Indices
Level 1:	30% students scoring more than class average percentage marks in the examination.
Level 2:	50% students scoring more than class average percentage marks in the examination.
Level 3:	70% students scoring more than class average percentage marks in the examination.
Attainment is measured in terms of actual percentage of students getting set percentage of marks.	

Table 1. *Levels of measuring the Course Outcomes attained*

Results and Discussion

In this section, the course-wise attainments are given for all the four semesters. The names and codes of the courses are changed to maintain the dignity of the associated program and to avoid any inconvenience to the main stake holders of the program. Initially, marks for all the courses are collected and attainment of COs are calculated. Overall COs are presented and analysed. Using the attainment of COs, attainment of POs is calculated and presented here. Analysis of attainment is done in the last section and significant findings in case of COs and POs are presented. Critical analysis with regard to the genuineness of the assessment in certain courses and their impact on the overall teaching-learning processes in the achievement of POs, PEOs, Mission and Vision is done.

CO assessment of all the courses of the program

Evaluation is based on both internal and external examinations. Internal examinations involve class tests, assignments and presentation. Normally, two class tests and two assignments are conducted per each course, as marks for four Continuous Assessments (CAs) in the form of CA1, CA2, CA3 and CA4 are to be submitted to the University as per the norms. The internal marks scored by the students are sent to the University. External examinations are conducted by the University at the end of the semester. Final marks or grades in the concerned course are given to the students, after applying suitable weightage to both the examinations. In this case, it is 70% to the semester-end examinations and 30% to the internal examinations. The overall marks of all the students are considered and average marks obtained for each course are tabulated in Tables 2-5. The overall CO attainment is also listed in these tables. Table 2 deals with the courses of first semester. ME 101 to 105 are theory courses and ME 106L, 107L and 207L are lab based courses. ME 108S and 206S are based on presentations by the students, which increase the oral and written communication skills of the students. ME 301P, 302P, 401P and 402P are project based evaluations. ME 403C is related to Comprehensive Viva, which is based on the testing of overall knowledge gained by the students in the entire program.

CO attainment in courses like ME 101, 103 and 105 is low as shown in Table 2. The average marks obtained by students is also low in these cases, except in ME 103. In this course, the average marks obtained by the students is good, but the overall CO attainment is not decent. This shows that the way of assessment is not respectable. Similarly, for the courses of ME 203 and ME 207L, the average marks scored is as good as 9.21 and 8.66. But, only 28.57% and 14.28% of students have crossed the class average. In case of ME 201 and ME 206S, 42.85% of students have crossed the class average, even it is lesser than that of 203 and 207L. The analysis specified in Table 3 clearly shows that the assessment is good only in few courses. In ME 204, still lesser class average is obtained, but the overall CO attainment is 3, which is the highest possible for any given course. The attainment of project based courses in the third semester, as shown in Table 4, seem to be on par with the achievement of students in the class. But, in the fourth semester, as shown in Table 5, there is problematic assessment observed in courses with regard to ME 402 P and 403 C. In these two courses, the class average is as good as 9.33, but the levels of attainment are very poor, as compared to other courses. The analysis clearly confirms the point of concern that the assessment or the teaching-learning process is not as desired in good number of courses, related to the program under study.

Particulars	Courses							
	ME 101	ME 102	ME 103	ME 104	ME 105	ME106L	ME107L	ME108S
Average marks	6.2	6.4	7.26	6.4	6.2	8.13	7.73	8.66
% of students crossing the class average	33.33%	60%	40%	53.33%	33.33%	60%	80%	66.66%
CO attainment = 100% * (Level achieved)	1	2	1	2	1	2	3	2

Table 2. *CO attainment for the courses of 1st Semester*

Particulars	Courses						
	ME 201	ME 202	ME 203	ME 204	ME 205	ME 206S	ME 207L
Average marks	8.07	9	9.21	7.85	9	7.73	8.66
% of students crossing the class average	42.85%	85.71%	28.57%	71.42%	92.85%	42.85%	14.28%
CO attainment = 100% * (Level achieved)	1	3	0	3	3	1	0

Table 3. *CO attainment for the courses of 2nd Semester*

Particulars	Courses	
	ME 301P	ME 302P
Average marks	8.66	8.66
% of students crossing the class average	58.33%	58.33%
CO attainment = 100% * (Level achieved)	2	2

Table 4. *CO attainment for the courses of 3rd Semester*

Particulars	Courses		
	ME 401P	ME 402P	ME 403C
Average marks	9.5	9.33	9.33
% of students crossing the class average	50%	41.66%	33.33%
CO attainment = 100% * (Level achieved)	2	1	1

Table 5. *CO attainment for the courses of 4th Semester*

Matrix of CO-PO relevance

The set of POs for the program under consideration are given in Table 6. These are prescribed by the National Board of Accreditation, which is the authority for the implementation of Washington accord in India. Three POs are as given by the regulating authority [7] and three additional POs are specific to the program, as designed and approved by the appropriate board of studies at the University level. These outcomes are pertaining to conducting research, preparing reports, obtaining advance knowledge in the corresponding program, the use of advanced technologies, experiment with different systems, design and develop solutions to real time problems in the area of manufacturing technology. According to the abilities expected at the end of the course, the COs are mapped to POs as shown in Table 7. Courses related to research/investigation and development work to solve practical problems are mapped to PO1. Basic courses and presentation or report writing based courses are mapped to PO2. Courses related to advanced technologies, which will make the students master in the concerned area are mapped to PO3. Similarly, the courses, where the advanced technologies are used are mapped to PO4. Experimentation based courses are mapped to PO5 and PO6 is associated with the courses, where there is design and development of solutions.

Program Outcomes (POs)	At the end of the two-year PG program, the students will be able to:
PO1	Carry out research/investigation and development work to solve practical problems independently.
PO2	Write and present a substantial technical report/document.
PO3	Demonstrate a degree of mastery over the area as per the specialization of the program.
PO4	Demonstrate the use of advanced manufacturing techniques.
PO5	Experiment with different automated, modern and flexible manufacturing processes and systems.
PO6	Design and develop solutions to real time problems in the area of manufacturing technology.

Table 6. *Set of POs for the program under consideration*

POs	Courses
PO1	ME 103, ME 104, ME 105, ME 204
PO2	ME 101, ME 102, ME 108S, ME 206S
PO3	ME 202, ME 203, ME 204, ME 205, ME 301P, ME 302P, ME 401P, ME 402P, ME 106L, ME 107L, ME 207L, ME 403C
PO4	ME 202, ME 203, ME 205, ME 301P, ME 302P, ME 401P, ME 402P, ME 403C
PO5	ME 106L, ME 107L, ME 207L, ME 301P, ME 302P, ME 401P, ME 402P
PO6	ME 105, ME 204, ME 205, ME 301P, ME 302P, ME 401P, ME 402P

Table 7. *Mapping of courses with POs*

Courses and POs	PO1	PO2	PO3	PO4	PO5	PO6
ME 101		1				
ME 102		2				
ME 103	1					
ME 104	2					
ME 105	1					**1**
ME 106L			2		2	
ME 107L			3		3	
ME 108S		2				
ME 201						
ME 202			3	3		
ME 203			0	0		
ME 204	3		3			**3**
ME 205			3	3		**3**
ME 206S		1				
ME 207L			0		0	
ME 301P			2	2	2	**2**
ME 302P			2	2	2	**2**
ME 401P			2	2	2	**2**
ME 402P			1	1	1	**1**
ME 403C			1	1		
Attainment obtained for 2021	**1.75**	**1.5**	**2**	**1.75**	**1.71**	**2**

Table 8. *Attainment of POs of the program*

PO attainment and analysis

The attainment of POs is calculated based on the mapping done in Table 7. As suggested by the regulating authorities, the attainment is based on course-wise attainments. The attainments of the mapped courses are used to calculate the individual PO attainment as shown in Table 8. The attainments of PO3 and PO6 are good and the attainment of PO2 is less. The attainment of PO1, PO4 and PO5 are same and are at the intermediate level, when compared to the attainment of other POs of the program. It is clear that the students at the end of the program will be able to demonstrate a degree of mastery in the areas of specialization of the program. Also, they will be able to design and develop solutions to real time problems in the areas of manufacturing technology. Based on the present levels achieved, targets can be set for the next year. PO-wise analysis shows that the concentration should be given to embedding presentation skills and experimentation aspects in graduates. Also, research aspects and advanced technologies should be given due importance. The presentation based courses like ME 108S and 206S should be more in an organized way and the way assessment is done in these courses should be looked into, for the betterment of the program. Similarly, the way courses like ME 203 and 207L are dealt should be thoroughly checked and if possible, the way teaching-learning processes or assessment are carried out must be changed.

Significant findings in case of COs and POs

In the calculation of CO attainment, interesting aspects are found. It is established that the level attained is low, even as the average marks obtained by the class is more. Only, in few courses, the pattern of assessment and teaching-learning processes seem to be good. Even in case of course involving viva, the attainment is 1 as only 33.33% of students have obtained more than class average. Even, in the final dissertation also, level achieved is less, but average marks scored by the students is high. It is clear that the betterment of average class mark does not mean better level of attainment. Proper ways of assessment must be employed in each course. The instructors should stick to designated ways of assessment possible to see that students attain marks in the examinations, based on their abilities gained through class room instructions. Awarding marks without proper evaluation has led to improper levels of course wise attainments. This is evident in few courses of the program under study. Even, few courses are not at all leading to the attainment

of at least few of the POs. PO attainments calculated in the program are reflecting such deficiencies. Also, all lab and project based courses are contributing nicely to the achievement of POs, except few. It is also identified that the POs suggested by the regulating authorities [7] are not taking care of levels [1] that need to be addressed to, in such a post graduate engineering program. The findings insist that the teachers need to be careful about assessment and marks are to be awarded based on the ideologies of valuation.

Conclusion

In this work, real time analysis of CO and PO attainment and their significance in case of a selected post graduate engineering program is carried out. Initially, the marks of the students are collected and analyzed. Average marks of the students are obtained for all the courses of the program. Based on the usual principles, CO attainments of all the courses are calculated and analyzed. It is observed that some of the courses like ME 101, 103 and 105 have low attainment levels. In-depth analysis revealed that the average marks obtained by the students is good in few courses, but the overall CO attainment is not good. This shows that the way of assessment is not respectable. On the other hand, in ME 204, even though class average is less, the overall CO attainment is as good as 3, which is the highest possible for any given course. Based on the CO-PO mapping, the CO attainments thus obtained are used to calculate the overall PO attainment. PO-wise analysis reveals that the assessment is good in only few courses, which are helpful to gain program level attainment. The analysis clearly confirms the point of concern that the assessment or the teaching-learning process is not as desired in good number of courses, related to the program under study. PO attainment is good in only few cases and in few more, care should be taken to improve further. PO based investigation indicates that the attention must be given to enhance the presentation skills and experimentation aspects in the outgoing graduates. Study finds that the ways of assessment in courses should be dealt carefully in the days to come for proper attainment of POs. Thus the present study presents the details of attainment in case of an engineering program, useful for the teaching community with suggestions related to the areas of concern leading to attainment.

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11 Computer-Aided Automatic Question Paper Generation Under Outcome Based Educational Framework

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Abstract

This paper proposes a technique for automatic generation of a question paper on a course under outcome based curriculum. Assessment of learning outcomes in outcome based educational framework is a highly challenging task. Various parameters e.g., Course Outcome (CO), Intended Learning Outcomes (ILO), cognitive levels as per Bloom's taxonomy, knowledge dimension etc., are to be taken into consideration while setting a question paper, especially for the purpose of summative assessment. Moreover, requirements of distribution of various types of items, e.g., objective type, short answer type, essay type, as well as the difficulty levels, are to be satisfied. Altogether, setting a question paper under outcome based educational framework has become a non-trivial and time-consuming task which is prone to human errors and imperfections. This paper proposes a software tool that will help the teacher to generate the target question paper, the moderator to moderate it and the controller of examinations to specify the format and other administrative activities. The problem is formulated as a Constraint Satisfaction Problem, and a technique to solve the problem on the basis of a Table of Specifications (ToS), has been presented. It is expected that the tool will be highly effective in tackling the complexities of outcome based educational assessment in a rational and efficient way.

Keywords: Summative assessment, Outcome Based Educational (OBE), Bloom's taxonomy, Table of Specification, Constraint satisfaction

Introduction

Assessment is one of the essential components of any educational system. It is important to all stakeholders in various ways. Assessment reveals the strengths and weaknesses of a learner which helps him to take necessary steps to fill up the gap in his knowledge and understanding. Moreover, on the basis of the results of assessment, he is able to compare his progress at a peer level and get motivated to do better, or take initiatives to cope with the peer level competition. On the other hand, the teacher is also benefited by the learning assessment of the learner. Not only he can assess the effectiveness of his instructional methods and strategies, but also, can identify the learner's difficulties which can be further addressed by the teacher. Through assessment process, the teacher can differentiate among the students and adapt suitable classroom strategies. And finally, the administrator can

make policies and structural changes to improve the system on the basis of the results of learning assessment.

There are numerous techniques of assessment. A popular one among them is the pen and paper test, which is a time-tested way of conducting summative assessment. A question paper is the necessary instrument for conducting the examination. Traditionally, teachers used to set a question paper on the basis of his subject knowledge, understanding of the curriculum, teaching experience and intuition. However, under the framework of outcome based education (OBE), the question paper is required to be developed in accordance with the so called table of specifications (ToS) and certain other constraints. These new requirements have rendered the task of setting a question paper more challenging. A number of attempts have been made to automate question paper generation ([1], [2], [3], [4], [5]). However, none of these has taken such essential features of OBE as the table of specification (ToS) ([6], [7]) and other related constraints into consideration. This paper has taken a holistic view of the situation involving all stakeholders including the teacher, moderator and the controller of examinations, and proposes an object oriented ([8]) approach to design and develop a software system for automatic generation of a question paper on a course under outcome based curriculum. Rest of the paper has been structured as follows. Section 2 describes the preliminaries of OBE and other relevant matters. In Section 3, a static overview of the proposed system has been provided. Section 4 describes the algorithm underlying the generator engine. And conclusions are drawn in Section 5.

Preliminaries

The outcome based educational paradigm is based on Bloom's taxonomy of educational objectives ([9]). Here the curriculum is structured on the basis of a hierarchy of outcomes, viz., Programme Outcomes (POs), course Outcomes (COs), Intended Learning Outcomes (ILOs) and the detailed contents are mapped to these outcomes. Usually a course has a number of (5-6) Cos and under each CO there are number of ILOs (3-5). While setting a question paper, the paper setter has to ensure that the test items are able to assess the achievement of these outcomes by the learner. For the purpose a Taxonomy Table is created where the rows correspond to the 4 knowledge dimensions (i.e., factual, conceptual, procedural and metacognitive), and the columns correspond to the cognitive process levels as per Bloom's taxonomy (i.e., remember, understand, apply, analyze, evaluate and create). With the help of the taxonomy table, a Table of Specifications (ToS) is created which is essential for setting a question paper under an outcome based curriculum. Fig. 1 shows a simplified ToS structure.

CURRICULUM				**COGNITIVE LEVEL MARKS**						
Module/Unit/ COs	Intended Learning Outcomes (ILO)	Teaching (in hour)	Teaching hour & Marks Sub-total	Remember	Understand	Apply	Analyze	Evaluate	Create	Total Marks
Unit1	ILO-1		10 hours & 17 Marks (Aprox)	3 Marks (3 of 1 Marks Each)	8 Marks (2 of 4 Marks each)	5 Marks (1 of 5 Marks each)	1 Marks (1 of 1 Marks each)	…	…	17 Marks
	ILO-2									
	ILO-3									
	ILO-4									
UNIT2										
UNIT3										
UNIT4										
UNIT5										
		0 hours								100

Fig. 1. *A Simplified ToS Structure*

Static Overview of the System

Fig. 2 depicts the static overview of the proposed system. There are three actors and six use-cases of the proposed system. The actors are: i) teacher, ii) moderator, iii) controller of the examinations. The six use cases identified are i) Create ToS, ii) Select structures, iii) Edit item bank, iv) Generate question paper, v) Edit question paper and vi) Archive question paper. As shown in the Fig. 2 the teacher is associated with the use-cases "Create ToS" and "Edit item bank". The role of the moderator is to "moderate" the question paper generated by the controller of examinations. Controller of examination is involved with selection of question paper format, generation of the question paper, and finally, archiving the question paper. Moreover, he will coordinate the activities of the teacher and the moderator. Each use case is briefly described below.

Create Table of Specifications (ToS)

This use case corresponds to creation of the ToS on the basis of curriculum, including the detailed syllabus of the course. The ToS will be created by the teacher, who is the subject expert. The system will provide the user interface through which the teacher feeds the relevant parameters to the system. The resulting ToS will be stored internally in the system and will be used by the question paper generator engine for the purpose of selecting appropriate test items from the Item Bank.

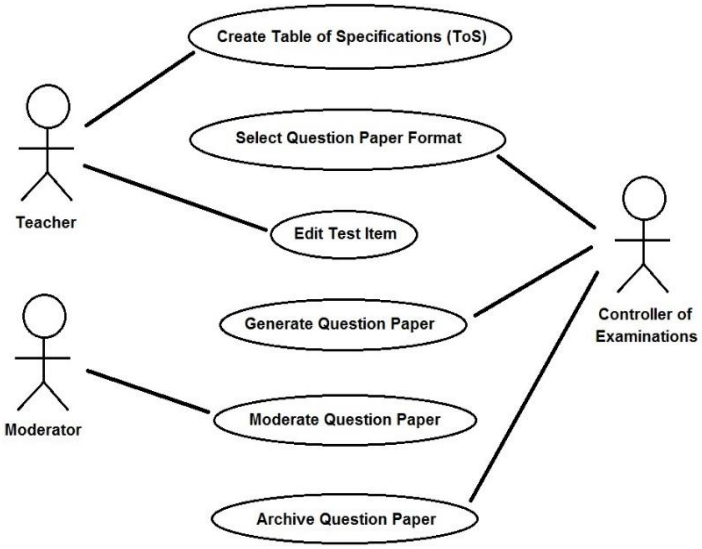

Fig. 2. *The Static Overview of the Proposed System.*

Select Question Paper Format

The format of the question paper must be selected before the generating it automatically. There are various formats of question paper. A few sample formats are mentioned below.

Sample Format #1

Let us consider a question paper of total marks 100. There will be 12 to 14 Questions each of 10 marks out of which 10 are to be answered. Each 10 marks question consists of two parts corresponding to the different Cos. A student has to answer any 10 questions. Marks of each part of a question is 5. Distribution of 5 marks may be any of the Fig. 3(a). The resulting format is shown Fig. 3(b).

Option #1	Option #2	Option #3	Option #4	Option #5
One 1 marks One 4 marks	One 1 marks One 2 marks	Two 1 marks One 3 marks	One 2 marks One 3 marks	One 5 marks

(a)
Course name, Time and other details
(answer any 10 questions, Maximum Score = 100)

Q. No.	Question	CO	Marks	Total marks
Q1	(a). …	CO_x	5	10
	(b). …	CO_y	5	
Q2	(a). …	CO_p	5	10
	(b). …	CO_q	5	
…	…	…	…	…
…	…	…	…	…
…	…	…	…	…
Q12	(a). …	CO_m	5	10
	(b). …	CO_n	5	

Fig. 3. *Sample Question Paper Format #1*

Sample Format #2

Fig. 4 depicts another sample question paper format. Here the entire question paper is divided into three sections, Section A, Section B and Section C. Section A contains 25 objective type test items each of 1 mark out of which the student has to answer 20. Similarly, Section B consists of 30 short answer type questions of 2 marks each. The student has to answer 25 among these. And Section C has 8 essay type questions (each 5 marks) of which the student has to answer 6. Maximum score is 100. Other formats are also possible. Before the Controller of Examinations runs the question paper generation engine, he has to select the format.

Course name, time and other details
Maximum Score = 100

Section A (Objective type) *Total marks = 20*
(Answer any 20 questions)
…
25 questions each of mark 1
…

Section B (Short answer type) *Total marks = 50*
(Answer any 25 questions)
…
30 questions each of marks 2
…

Section C (Essay type + Numeric type) *Total marks = 30*
(Answer any 6 questions)
…
8 questions each of 5 marks
…

Fig. 4. *Sample Question Paper Format #2*

Edit Test Items

Editing a test item involves the activities including writing a new test item or modifying an existing one and then storing them into the Item Bank. The Item Bank will be created by the teacher because it needs subject expertise as well as a thorough knowledge of the curriculum. While writing a test item, the teacher has to specify all parameters e.g. CO, ILO, difficultly level, marks etc. for the item.

Generate Question Paper

When the Item Bank is filled with enough number test items, and the format of the question paper is fixed, it is possible to generate the question paper automatically with the help of the generator engine. This is initiated by the Controller of Examinations. The generator engine automatically generates as many question papers as required by the Controller by running the internal procedure which will be described subsequently.

Moderate Question Paper

Once the question paper is generated, it is assigned to the moderator for moderation. This has to be done manually. The moderator has access to the generated question paper, which he can moderate online. After moderation, the final question paper is submitted for further actions.

Archive Question Paper

After the examination is over, the question paper is archived in the internal library of the system for future reference. This action is initiated by the Controller of Examinations.

Algorithm

The underlying algorithm for automatic generation of the question paper follows a strategy of constraint satisfaction. The most important constraint is provided by the ToS which has been discussed in Section 2. Some other constraints are distribution of difficulty levels, distribution of cognitive dimensions, distribution of knowledge dimension, distribution of question types etc. Some examples are cited below:

(a) Difficulty Levels Distribution

Out of 120 marks, 60 marks from level 1, 40 marks from level 2 and 20 marks from level 3

(b) Cognitive Dimensions Distribution

Out from 120 marks, 60 marks from level 1, 40 marks from level L2, 20 marks from level L3

(c) Knowledge Dimension Distribution

Out of 120 marks, 50 from factual, 40 from conceptual, 20 from procedural, 10 meta-cognitive

(d) Question Type Distribution

Out of 120 marks, 20 objective type, 40 short answer type, 40 numerical and 20 essay type

A question paper consists of a number of test items. Each test item has various parameters associated with it. Under object oriented paradigm, it is possible to define a class for Test Items. Fig. 5 shows its structure.

Class Name: Test Item

Arguments		
No.	Name of the Argument	Data Type
1	Course Name	Alphabetic String
2	Course Code	Alphanumeric String
3	CO	Alphabetic String
4	CO no.	Integer
5	ILO	Alphabetic String
6	ILO no.	Integer
7	Cognitive Process Level	Integer (1-Remember, 2-Understand, 3-Apply, 4-Analyze, 5-Evaluate, 6-Create)
8	Knowledge Dimension	Integer (1-Factual, 2-Conceptual, 3-Procedural, 4-Metacognitive)
9	Item Type	Character (O-Objective, S-Short answer type, N-Numerical, E-Essay)
10	Difficulty Level	Integer (1-Easy, 2-Moderately hard, 3-Hard)
11	Marks	Integers
12	Item Body	Character String
Methods		
1	CREATE a new Test Item	
2	EDIT an existing Test Item	
3	INCLUDE a Test Item into the Item Bank	
4	REMOVE a Test Item from the Item Bank	

Fig. 5. *Structure of the Class Test Item*

The entire procedure for automatic generation of the question paper is shown in Fig. 6. First the ToS is created by the teacher, which is followed by creation of the Item Bank by the teacher. When the ToS and Item Bank are ready, the process of question paper generation begins. At each step of this process, an Item is selected from the Item Bank (perhaps randomly). Then it is checked whether the parameter values of the newly selected Item do

not violate the current ToS and other constraints. If yes, then the item is included in the partially created question paper and the ToS as well as the constraints are updated accordingly. This process goes on till no more Items can be included in the question paper. The output question paper is forwarded to the moderator by the Controller of Examinations for further moderation.

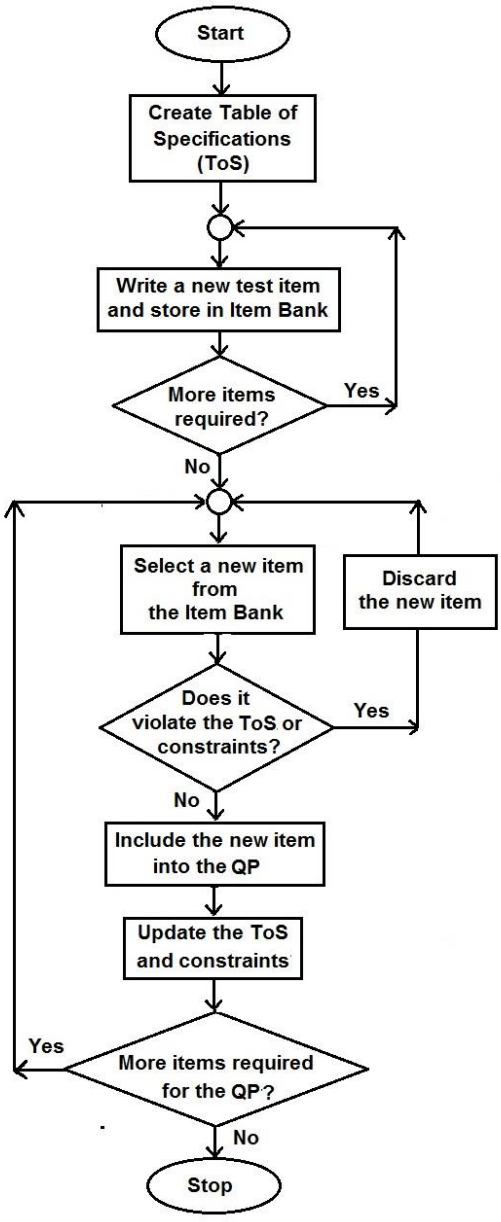

Fig. 6. *Procedure for Automatic Question Paper Setting Under OBE Framework*

Conclusion

A technique for automatic generation of a question paper on a course under outcome based curriculum has been proposed in this paper. The proposed algorithm takes into consideration various parameters e.g., Course Outcome (CO), Intended Learning Outcomes (ILO), cognitive levels as per Bloom's taxonomy, knowledge dimension etc. while generating the question paper. Distribution of various types of items, e.g., objective type, short answer type, essay type, as well as the difficulty levels, are incorporated into the procedure as constraints to be satisfied. The entire task is formulated as a Constraint Satisfaction Problem, and the technique to solve the problem has been designed to satisfy the Table of Specifications (ToS). On implementation, the proposed software will help the teachers, moderators and the controllers of examinations to accomplish the complex task of setting a question paper within an outcome based educational framework easily and efficiently.

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12 Effectiveness of Blended Learning in Engineering Education During the Pandemic

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Abstract

Blended learning blends the classroom and online course methodologies. The instruction of a lesson comes through teachers' and computing devices' interaction. In this pandemic situation, due to social distancing, students are restricted from attending regular classroom teachings. As a result, the quality of engineering education is decaying. In this paper, many experimental results, which show the difference between traditional and blended learning methods, are observed. Therefore, after observing various experimental results in different fields, that the blended learning method is improving both the student's interest in the subject and learners' academic result, we propose an advanced blended learning process. To make the engineering study more interesting in this pandemic, this proposed advanced blended learning process is going to be the most effective only alternative system to uplift the EEQ. The opening of this proposed education system starts with an object for the students along with the study materials (online classes & e-learning). Simultaneously, an assignment and weekly test are conducted to assess the students' interest and involvement in the study (via online mode). 24 x 7 support programs are provided along with clarification. Subsequently, a provision is kept for workshop experience with minimum students at a time in the laboratory physically for the hardware base subjects which include costly & risky tools. This way students can avoid gathering for safety but at the same time, they are learning with growing interest and developing deep knowledge which will uplift the EEQ.

Keywords:
Blended learning, hybrid learning, pandemic situation, E-learning, engineering education quality(EEQ), moderate constructive method

Introduction

In this pandemic situation people are forced to transform most of their activities such as official, educational, social, cultural activities into digital from manual. Science and technology are evolving so fast that education is required to respond to these developments. Engineers have a great contribution in this fast-changing new normal scenario when almost everything is done digitally.

The new era requires a change in the education system so that the world of education becomes more pertinent to the new opportunities in our life. To overcome the obstacles of scientific and technological development, high skilled resourceful information is required which includes complex mindful, systematic, logical, and effective collaborative thinking skills. Today's world also insists on the ability to work together in a group, problem-solving, self-

regulating, interpenetrating, technological, and effective communication abilities. The skills, mentioned above, are in demand for the 21st century. So the learning process should be able to encourage the creation of these capabilities. In addition, the education culture should be able to create human beings who can learn, adapt and innovate [1]. Students are required to have academic skills, and also enhance their skills. The thought process, according to the challenges in the new era, needs to be improved in learning Mathematics. Mathematics can create a creative mind by developing thoughts that are divergent, original, curious, predicting and guessing, and experimenting. The most effective alternative learning in constructiveness view that can be applied to improve student's activity and creativity is applying Blended Learning [2].
Due to recent advanced communication technology (ACT) the new normal teaching methods are being reconsidered and have caused significant changes in distance teaching [3]. Technology supporting e-learning is not effective unless attention is paid to the fact that the type of instructional model plays a critical role in technology-enhanced education [4].

In 2005, experience was assembled from the past few years teaching the 3rd year Program Development Model course unit which is 5 year engineering degree program in computing. In this prime undergraduate degree programs are covered by the Computing Curricula developed by the Joint Task Force for Computing Curricula formed by the IEEE Computer Society, the Association for Information Systems, and the Association for Computer Machinery [5]. In this paper for the past few academic years (2006–2008), 200 final year students got 4.2–4.4 out of 10 in this course unit. Including this failure, the student dropout rate was increasing, where between 25% and 35% of students was unable to appear in the final examination as they considered themselves unprepared to pass. A medium constrictive e-learning model with a hybrid learning approach along with psycho-pedagogical prescriptions was built for students keeping their requirement of knowledge in mind. A number of professionals in the subject built a blended-learning solution [6] - [8], a concept that has mixed activities both teacher-student interaction and student-computer interaction [9]. The blended model of learning applied in this system merge 3 processes: self-paced learning (more effective in higher education) [10]; live e-learning where students can do teamwork [11]; and traditional classroom learning [12].

In this study, an advanced blended learning method has been used, which includes virtual teacher student interaction (online classes), e-learning (enriched study material), student-computer interaction & workshop physically for the certain subjects, comprising expensive & heavy gadgets, like industrial lab, mechanical lab, sensor & transducer lab, electrical lab & etc. (with minimum no of students at a time). It is found that the result of blended learning is always better than the conventional learning. In this pandemic situation, almost every single engineering institute is performing their educational journey through online mode. In engineering some subjects can be learnt easily via online like software subjects (computer language learning and applying, app developing & also the theory part of any subject) but the hardware subjects, like electrical, instruments, industrial, mechanical, civil & etc., need practical high-tech knowledge. Those fields need real world experience which is only possible through physical presence in laboratory or field. That's why our proposed learning method can take the EEQ in the next upper level where students will feel more connected with the subject and will develop critical problem solving attitude.

Methodology

Moderate constructivist e-learning instructional model

In 2009, a learning method named Moderate conductivity instructional was applied on both distance and blended learning students. The aforesaid method included knowledge from different methods basically the design and implementation part was taken from the performance matrix [13]. Depending on a learning object (method, principle, skill, process), contents are made for education. After knowing a specific skill, students have to solve some problems [14]. in this process when learners are introduced to some real problem-solving process, learners will understand the theory much deeper and this will help their mind to think more creatively and

constructively. it is a more realistic approach that focused on moderate constructive [15], [16], with the use of technological tools.

The moderate constructive e-learning instructional model is based on the fact that learners can apply the concepts learned in class and assess the methods, processes with tools. For doing this, the instructional model is built with 5 steps: analysis, design, implementation, execution, and evaluation.

Analysis

In this stage teaching content and resources are decided based on the learners' needs so that they can have the best knowledge. These contents are presented as different steps in a flow chart as AND/OR graph. Each step contains different educational knowledge in an organized sequence and is considered as nodes. The arrows that connect the nodes define the task to be done to achieve the next level task. OR learning occurs when two or more arrows are pointing a node, which means you have to complete at least one task before going to the next stage. AND learning occurs when two or more arrows are pointing a node and you have to complete both tasks before going to the next level. Thus, in this phase, all possible knowledge sequences can establish for upgrading learners' knowledge level from basic to the targeted level. In this way, the learners are completing all the needed tasks. This educational model gives chances to choose the next learning in level which they are more interested. So, this constructive learning process is also an object-driven instructional model [17].

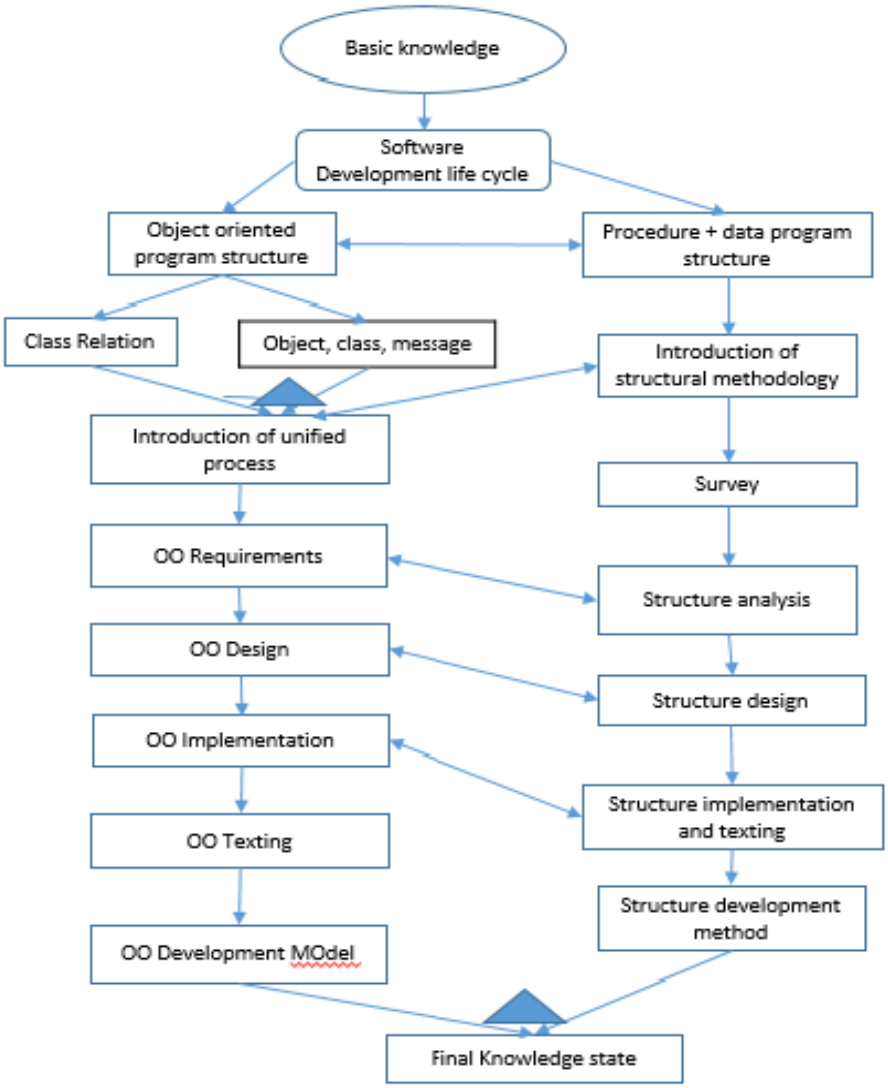

Fig. 1. *Object Orient Programming Language Learning Model*

In Fig. 1 the structure of the learning objects is graphed step by step and it has OR and AND learning sequences, that provide the students great freedom. Like if the learner has to complete the object-oriented program structure then there are three options to choose from next. And before going through the Introduction of Unified process the learners have to complete both the class relation and object, class, message stage.

Design

The design is shown in Fig. 1, the learning objectives are added in each step of the model that contains educational contains, good problems to be solved by teamwork that covers all the concepts from the educational concept. In this problem-solving process, a learner needs inexpensive equipment, group efforts. A good problem is that where a learner can use all the knowledge together what has been taught to them.

Implementation, Execution, and Evaluation

The road map was made in the implementation phase (educational process and the learning contains) into a learning management system (LMS) platform by SCORM compatible authoring tool. In the execution phase, the students do the e-learning course. In this stage, information is given on the problems encountered and the knowledge acquired. Information output during execution is collected, and the results are analyzed for evaluation. For the educational content learning objects and the good problems, the total time each learner spends on learning an object is observed, and the interaction between learners, and between learners and the instructor, as well as the number of questions formulated by the learner are recorded. Finally, the grades that learners achieve in the evaluation exercises and the total time they spend on learning an objective are stored.

The content expert can analyse this information to find out whether an educational content learning object should be revised—for example, if the mean time spent studying the learning object is significantly higher than originally estimated by the content expert at design time. Similarly, it provides the instructor with statistical data about the execution of the learning objectives, giving clues as to whether any have been poorly designed. From this information, the instructor can conclude abnormally low grades or there is too much interaction to solve a good problem.

Online Class

Now during this pandemic situation, all the education courses are happening from distance through online classes. The outcome of an online class depends on the online environment and the quality of the course. In higher class students are more mature and sincere, that's also an important factor for a succession of online classes. In engineering education classes are taken by Google meet or Zoom app virtually, hence students can attend classes regularly from anywhere. The is no barrier of distance, traveling, and others. The education system has become hassle-free, comfortable, flexible, and more acceptable by the new generation. There is a difference between smart work and hard work, young generation students always like smart ways as they are more advance in technology and can adapt to new things very fast. This is a synchronous process where both teacher and learners have to schedule a common time when they will be available. In online classes, the teacher can easily explain a certain topic to the students with PPT or whiteboard by sharing a screen, if students have doubts they can ask the teacher, basically this is a digital version of the classroom teaching process [18].

Blended Learning Approach

This blended learning approach has the above-mentioned Moderate Constructive Instructional model, online classes, and other three learning models: e-learning, self-paced and face-to-face classroom learning (especially for hardware practicals, like - Industrial lab, sensor-transducer lab, electrical lab, etc.).

In e-learning, teachers made good quality videos with or without screen share, PowerPoint presentations, or a digital whiteboard. The videos are sent to all the individual students so that they can learn from the video whenever they want. It also includes a brief description of an object, problem-solving techniques, and assignments. The self-paced part is an asynchronous part of learning.

Students can do this part by forming groups, sharing information, group work is always more beneficial rather than individual effort. Online classes are taken regularly on weekdays where learners can discuss any topic they are struggling with or any particular problem-solving method. The fourth ingredient is face-to-face classroom traditional teaching techniques. Despite having some defects and problems this face-to-face interaction, with teacher-students and among students, is invincible for building social competent characteristics within students. They will be able to connect with people more emotionally, the subject will become more interesting and exciting for them. Since in this time gathering is not allowed, with maintaining right protocol and with minimum students, weekly classes can be organized. This is optional for the software department as they can do all the parts over online interaction. But for those students who have the hardware part as their lab or practical like Industrial instrumentation, Sensor and transducer, Electrical and electronics, control system, Bio-technology, mechanical, civil, etc, it will be better for having a lab class in a week with minimum divided student groups.

The approached blended learning for one subject will be executed as described below:

There is a minimum of 16 weeks for completing a particular subject before the qualification round. So each topic can be done in this rhythm.

1. The course will start with one 2-hour online class, where the learners get the chance to meet with their teacher and their classmates. In this class, a teacher will describe the object, theory part, necessary rules, and give a task to be done.
2. Learners will receive the subject-oriented e-learning materials and the assignment contains 10 numbers of questions. They will have a time limit before having the next class.
3. In week 2 or 3 online classes of at least 2 hours will be there as needed. Students will do the given task in group study or by an individual. In the next class, they can ask their doubts, struggling while solving any problem.
4. Online support will be available. If any learner has any kind of subject-related question they can post that in their online group like what's app group, telegram group, or can directly mail the instructor. That should be replied to within 24 hours.
5. Additional 1-hour online classes should be there, which will be helpful for the students who were not able to attend the previous class. As well as this is good for learners' interaction and learners and instructor interaction.
6. A online test will be held every week with a minimum of five short answer-type questions with monitoring by web camera and microphone on.
7. After completing a hardware theory that needs practical knowledge, the lab class will be organized in that week as face-to-face interaction with a minimum number of students. As a class with 40 number students, the lab will be held with 10 students at a time. Thus, there must have a four-time slot in that week when the instructor and students will gather in the institute and have they're require knowledge shared. This is optional for the subjects which can be well understood online.

Result and Discussion

An experimental study was done with this blended learning in the year 2009 on undergraduate computer science students at University of Madrid. The rate of dropout students in the Program Development Model Course Unit was increasing in that institute. Students participated in traditional face-to-face classroom teaching in 2006, 2007, and 2008 year. In the 2009 year, blended learning (included e-learning, self-space learning face-to-face learning, and constructive learning model) was applied to 693 students. Out of those 693 students, 264, 198, 124students received face-to-face classroom teaching in 2006, 2007, 2008 year respectively, and the rest 107 students received instruction during the 2009 academic year. Among the 107 students, 55 students chose blended learning as the other 52 students chose distance learning. The age range was 20-23 years old, and the ratio of gender was about 80% male and 20% female approximately. The subject was taught by two

same teachers in three different methods. The academic record was taken as blended learning (BL-2009), distance learning (EL-2009), and classroom learning (FF-2006, FF-2007, FF-2008). Each student was getting only one instructional learning method, the educational contain was the same as they were in the same year of an undergraduate course.

	Number of students	Lowest Marks	Highest Marks	Average marks
BL-2009	55.00	1.25	9.00	5.08
EL-2009	52.00	1.13	7.75	4.86
FF-2008	124.00	1.38	9.00	4.44
FF-2007	198.00	0.38	7.88	4.21
FF-2006	264.00	0.25	8.25	4.27
Total	693.00	0.25	9.00	4.40

Table 1. *Result of different learning methods in form of points out of 10 points*

By observing the academic records in Table 1. It is shown that the e-learning method has a better result than only face-to-face classroom teaching. This is due to e-learning is individualized as students learn from self-study, the self-assessment, students had group work. Here students were free from a systematic life as they can learn from anywhere at any time. All these factors motivated learners and a better output accrued.

On other hand blended learning included a moderate constructive e-learning method had the best result out of the three methods. And the main concern of this project, the increasing dropout rate of students, was dramatically reduced shown in Fig 2. In the years 2000 and 2001 around 80% of students were taking the course. Then the evolution dropped and remain the same between 60-70% since the 2008 year only in the 2006 year the evolution was 73.74%. After applying the blended learning method, the evolution rose to 78% [19].

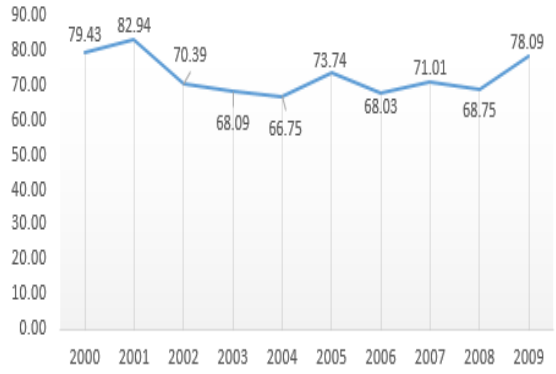

Fig 2. *Graph of students attending the practical program development course over 10 years*

In 2016-2017 academic year another study was done on 34 students who were in 3rd and 4th year at German Jordanian University. The learners were selected randomly from two different classes of English and then divided into two groups experimental (16 students) and conventional (18 students). In experimental group students were learning through classroom and e-learning teachings. A test was conducted with 10 questions before the experiment begins, where one student can score maximum 40 points. The questions had difficulty transactions ranging from 0.30 to 0.85 and discrimination coefficients from 0.36 to 0.95. To ensure the reliability of the test randomly 10 students (6 male students & 4 female students) from 3rd and 4th year were chosen, who were not the part of the experiment but studying the same major. The reliability was 0.83 using **Pearson** equation (thumb rule: $r<0.3$, Very weak; $0.3<r<0.5$, Weak; $0.5<r<0.7$, Moderate; $0.7<r$, Strong) which is strong and homology coefficient was 0.91 using **Cronbach's** alpha equation (thumb rule: $\alpha \geq 0.9$, Excellent; $0.9>\alpha \geq 0.8$, Good; $0.8>\alpha \geq 0.7$, Acceptable; $0.7> \alpha \geq 0.6$, Questionable; $0.6>\alpha \geq 0.5$, Poor; $0.5>\alpha$, Unacceptable) which is excellent.

For 14 weeks the 34 students learnt according to the two different learning methods and after that, achievement test was administrated. The scale measuring the motivation in learning the subject was also administrated to the students in the experimental group. In table 2. the arithmetic mean of pre-experiment and post-experiment, modified mean of post-test and standard deviation of both tests depending on the difference of experimental and conventional groups are calculated.

Teaching method	N	Pre-experiment result		Post-experiment result		Modified mean	Error
		Observed mean	Standard deviation	Observed mean	Standard deviation		
Conven-tional	18	24.51	7.91	29.35	5.97	29.457	0.815
Blended learning	16	24.91	8.12	32.37	6.63	32.266	0.777

Table 2. *Observed and modified means of pre and post experiment*

Table 2 shows the existence of virtual difference between the means of conventional and experimental groups in post-test. On the achievement post-experiment was attributable to teaching methods, in which the students in the experimental group (modified arithmetic mean = 32.266), who were taught using BL and the conventional method, performed better than their counterpart in the control group (modified mean = 29.457), who were taught using the conventional method only [22].

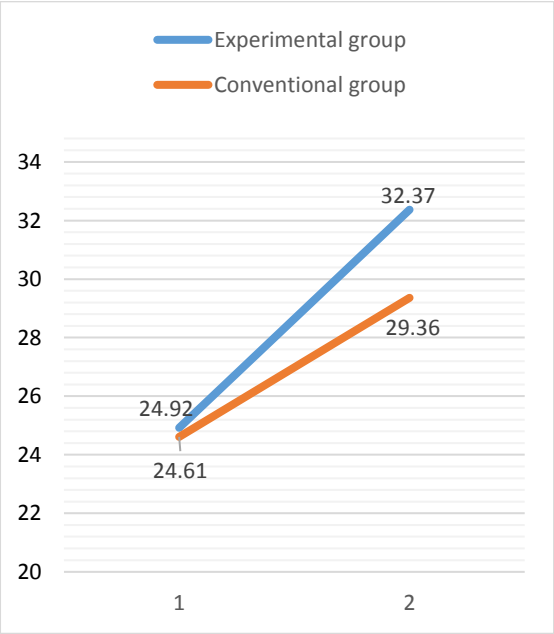

Fig. 3. *Students' achievement of each group*

For better understanding the achievement of students shown by graph in Fig-3. The blue coloured line represents the experimental group's achievement and the orange line represents the conventional group. Clearly it has been observed that the experimental group's achievement slop is higher than the conventional group.

The means for each of the pre and post experiment motivation scales were calculated (Table 3). The findings showed a virtual difference between the modified means of the post-English language learner motivation scale. Learners who had blended learning approach find the subject more interesting than the conventional group students.

Teaching method	N	Pre-experiment scale		Post-experiment scale		Modified mean	Error
		Observed mean	Standard deviation	Observed mean	Standard deviation		
Conventional	18	1.876	0.095	1.847	0.135	1.835	0.024
Blended learning	16	1.835	0.101	1.938	0.061	1.938	0.023

Table 3. *Observed and modified means of pre and post learners' motivation scale*

In Fig-4. the change in motivation in each group students can be seen. The blue coloured line which represent experimental group has higher positive slop than the orange coloured conventional group which has rather negative slop. So, the conclusion drawn that the students from experimental group has a positive change in motivation towards the subject, and the conventional group loos interest in the subject.

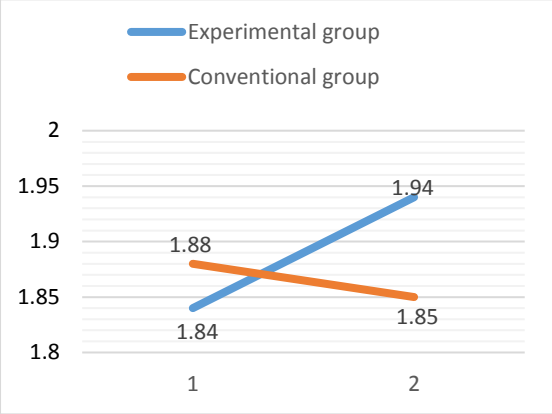

Fig. 4. *Change in motivation of students toward the subject in each group*

Thus it's shown, how blended learning helps in growing interest in learning subject and the results are better than the traditional learning. Online interaction may cover up the situation but it gradually decreasing the quality of engineering education specially for the hardware related curriculum. So, when the entire world is facing this deadly pandemic situation, blended learning is useful in maintaining the quality of engineering education. Students can avoid most gatherings and also can do minimum face-to-face practical labs as needed in some hardware-related subjects. The young generation of students always loves to use, learn and apply advanced technologies. This proposed advanced blended learning approach has included some awesome new advanced technology usage, as well as the learning techniques which is going to be most exciting, fun, and interesting for them and better output will come up. This result shows that blended learning is not only acceptable to students but also favourable to them.

Conclusion

As it's known that education quality has been affected a lot during this covid-19 scenario, regular classroom face-to-face teaching is avoided for safety reasons. Online classes are taken as an alternative to face-to-face teaching, e-learning is also provided to the learners, but only one method is not enough for a proper education structure. In this case, only sincere students are taking all those contain seriously as in the online class a teacher can't monitor all the students at a time, also major students keep their video and audio off with an excuse of poor data connection, limited data. Like this, if only e-learning is provided to the students they will not do the learning regularly as there is none to monitor their work.

So blended learning included online classes, e-learning, moderate constructive e-learning method with minimum classroom teaching for hardware practical knowledge (like an industrial instrument, mechanical workshop, etc which are expensive) will help to maintain the quality of engineering education. The subject experts have to design the moderate constructive model with high quality of educational content, practice model, good problems with proper solutions. In this way, an instructor can monitor each student's performance and help them out where they are facing problems in a personalized way. And besides this, there is a weekly exam on the topic they recently taught, students can solve problems with the group. Besides while attending any exam the web camera and microphone will be on so that the actual result can come.
Thus in this proposed blended learning model, the quality of engineering education will remain high and students will enjoy while learning. But this method needs more labor from teaching stuff than in the traditional face-to-face learning process.

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13 Development of Inventory Management System: Case Study of NITTTR Kolkata

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Abstract

An inventory management system is the combination of processes that oversee the monitoring and maintenance of stocked products, whether those products are company assets, raw materials, and supplies, or finished products ready to be sent to vendors or end consumers. Companies need to have inventories in warehouses to fulfil customer demand, meanwhile, these inventories have held the stock reports, costs, bills and this is a frozen fund that can be lost. It is known that this manual system is time-consuming, unsafe, and full of human errors. This inspires us to develop a web application software that will organize the inventory data and be able to track the stock in the storehouse along with real-time information about existing stock and allows accomplishing the need of stakeholders. To make it practical, we have done a case study of the manual inventory system of NITTTR Kolkata that includes their stock, issue, requisition, report, etc. in the form of ledger. This paper describes our inventory management system software which provides different features to the admin, storekeeper, faculty and other staff members. The backend of the system has been developed using PHP, MySQL along with the front end of the system has been designed and developed using HTML, CSS, JavaScript, and jQuery. The Entity Relationship diagram and Data Flow Diagram have been shown to illustrate the functionality of our system graphically.

Keywords: DFD, ER diagram, Inventory Management System, MySQL, PHP

Introduction

An inventory management system is a process of ordering, storing, using, and selling a company's inventory and is responsible to track goods throughout the entire supply chain, from purchasing to production to end sales. Traditionally, inventory management involved making updates or changes to spreadsheets or paper every time when more inventory was ordered, a sale was made, and items were shipped. It should go without saying that the traditional process of manually tracking inventory is time-consuming and prone to human error. With traditional inventory, it's almost impossible to expand one's logistics operations and still be able to track and manage inventory throughout the network [1]. It has

motivated us to build a digital inventory management system that will reduce human error, improve accuracy and productivity, and streamline the information. Our system ensures that there is no discrepancy between the actual physical inventory stored in a warehouse or elsewhere, and what is recorded. Automatically recording real-time data improves higher inventory accuracy across the supply chain and lowers the chances of inaccurate inventory accounting. It will also help to boost up the supply chain productivity and reduce inventory carrying costs [2].
Globally, inventory management is a challenging problem area in supply chain management. Every organization, which deals with the raw materials, puts its great effort in the efficient utilization of its raw, material according to its need and requirement. The organization has to perform several tasks and operations to run its business through manual system [3]. Traditional inventory management lacks this level of inventory visibility and makes it difficult to have an accurate picture of stock availability across multiple locations and channels. The need for automating the warehouse arises from the fact that manual handling may cause human errors which may affect warehouse utilization. In order to automate the process, a thorough study of the system should be conducted [4].

In this study, we have developed a web application of an Inventory Management System by using some advanced web technologies like HTML, CSS, PHP, MySQL, and JavaScript. At first, we performed a survey of the central store of NITTTR Kolkata, where the whole information has been maintained by four ledgers. Since the manual system is time-consuming, unsafe, and also required lots of human effort, while our application reduces the disadvantages of the manual system. To make the application safe and secure the user can access our web application by providing their credentials on the login page as Admin, Store Keeper, FIC IWS, FIC Electrical and Faculty, and Others. The Admin can see all the reports and can also print all the reports. The Store Keeper can perform eight different operations, as entry of Stock Non Recurring, Stock Recurring, Issue Recurring, Current Stock Recurring, Stock and Issue Recurring for FIC IWS, Stock and Issue Recurring for FIC Electrical, Requisition, Report and Search. The FICs and faculty and other stuff members of NITTTR can send requisitions to the store keeper and also, they can see the status of their requests. After getting the requisition, the Store Keeper checks the availability of a required item, if it is available the item will be issued otherwise the item will be purchased according to the requirement. After issuing the required items by the Store Keeper, The FIC IWS or FIC Electrical can endorse the issued item accordingly. The Faculty and Others can send requisitions to Store Keeper and see the current and previous requisition. The whole paper is organized in four sections. Section 1 contains introduction. The survey of central store of NITTTR Kolkata discusses in section 2. Section 3 describes development of Inventory Management System for central store of NITTTR Kolkata, while Section 4 concludes the article. The system is currently running in the internal server of NITTTR Kolkata and can be accessed using this url[1].

Survey of Central Store of NITTTR Kolkata

Currently, NITTTR Kolkata has used a ledger to manage its stock records, requisitions reports. There are mainly four ledgers that are used to maintain the data related to the assets, stock entry, issue items, and all the item requests that are requested from the faculty as shown in Figure 1. In this manual system, one needs to write everything on record. This ledger provides a detailed audit trail of all inventory transactions. It stores information regarding stock items and associated quantities but includes the buyer's accounting distribution for report writing purposes. All accounting transactions produced by inventory transactions has been recorded and posted to General Ledger. Here, the Stock Ledger of Recurring Items has been used to maintain the data related to the assets of this institute as shown in Figure 1(a). The Asset Ledger of Nonrecurring items maintain the data related to the assets of this institute as shown in Figure 1(b). For managing the items Figure 1 (c) shows the issue register which is issued by the Store Keeper. Similarly, the Stock and Issue Recurring maintains all the stocks

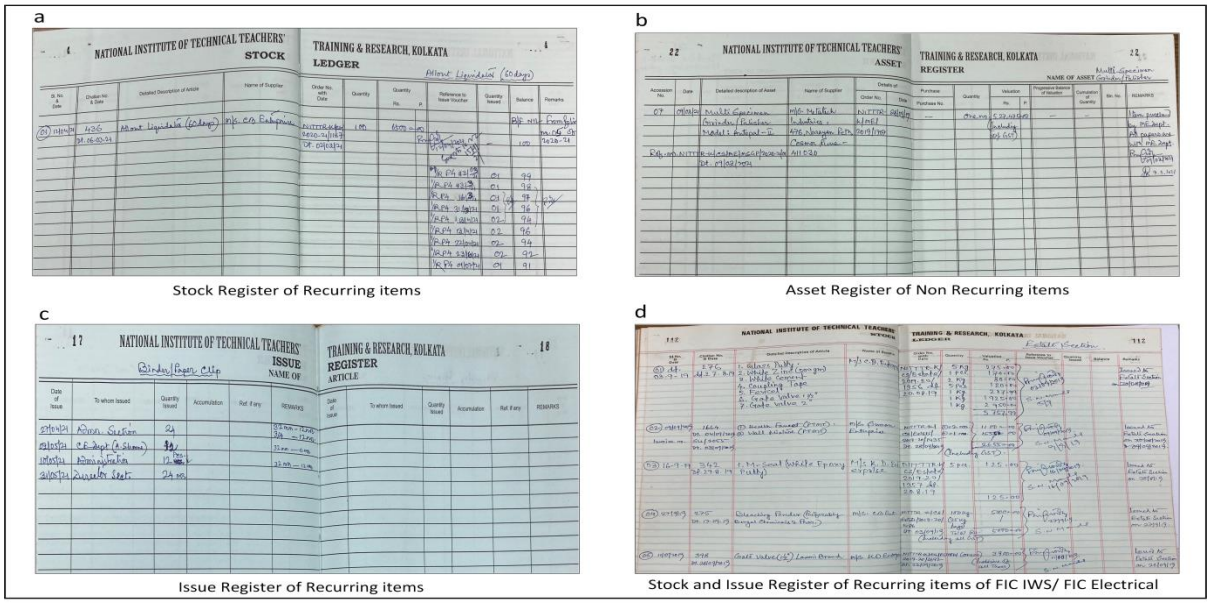


Fig. 1. *(a) Stock Register of Recurring items, (b) Asset Register of Non-Recurring items, (c) Issue Register of Recurring items and (d) Stock and Issue Register for Recurring items of FIC IWS/ FIC Electrical, to maintain Inventory of Central Store of NITTTR, Kolkata*

As shown in Figure1, FIC IWS, FIC Electrical, and other Faculties have to make the request to store keeper then as per the current stock availability, storekeeper issues that particular item and update the entry with a sign. After that, faculty who requested, update the entry with their sign and give approval that shows the item has been delivered.

In a manual system, one can see a register but in the case of an automated inventory system, one can access data by using others' usernames and passwords. In a manual system, there is no need for electricity and other things like an automated inventory system. This system is time consuming; it requires employees or a person to write each inventory. It is very difficult to track each purchase and maintaining this system every day. At the end of the day, the count will not be updated in the manual inventory system. It means if one wants to order something, then she/he has to go through each inventory item and it is a very difficult and time-consuming process. Managing this is tough. In this system, there is a need to write everything on paper and it can be misplaced easily. It is less secure than inventory management web application software. Here, one can write limited words in any block and we know that sometimes paperwork can take much amount of space but we cannot write according to need. In a paper system, one cannot edit any entry whereas in web application software one can edit entry anytime.

Development of Inventory Management System for Central Store of NITTTR Kolkata

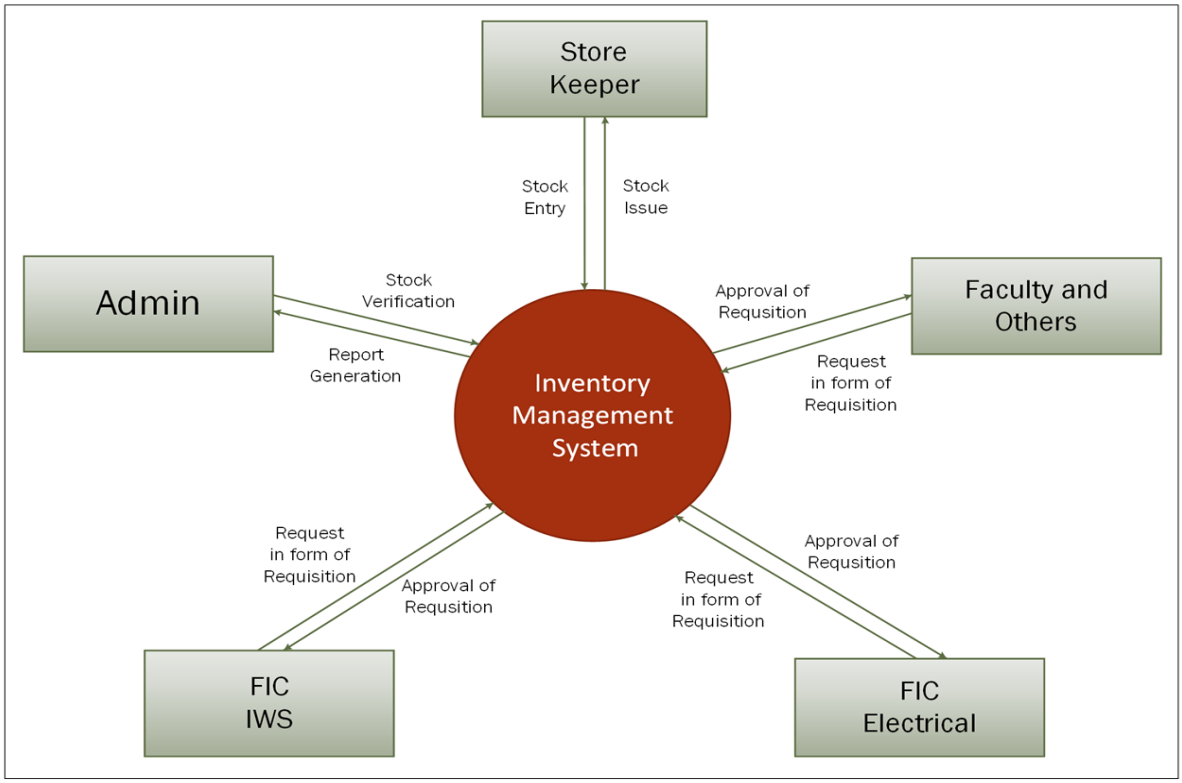
Based on the case study of NITTTR Kolkata, this inventory management web application software has been developed. This software resolves all the problems which were coming in the ledger system. This system is secured and completely safe as it is password protected. Without login, no one can enter the system. It is very accurate and it can provide a complete report at any time. One of the most important advantages is that it can be used from anywhere and the information can be obtained anytime. It is very easy to operate and one can understand it easily. This system has been developed using PHP. Here database used is MySQL and on the basis of provided data of eight tables all databases have been developed. Entity Relationship Diagram and Data Flow Diagram are developed to analyse the flow of data and all components of the system.

Data Flow Diagram of Inventory Management System

A data flow diagram is a way of representing a flow of data through a process or a system i.e. usually an information system. The DFD also

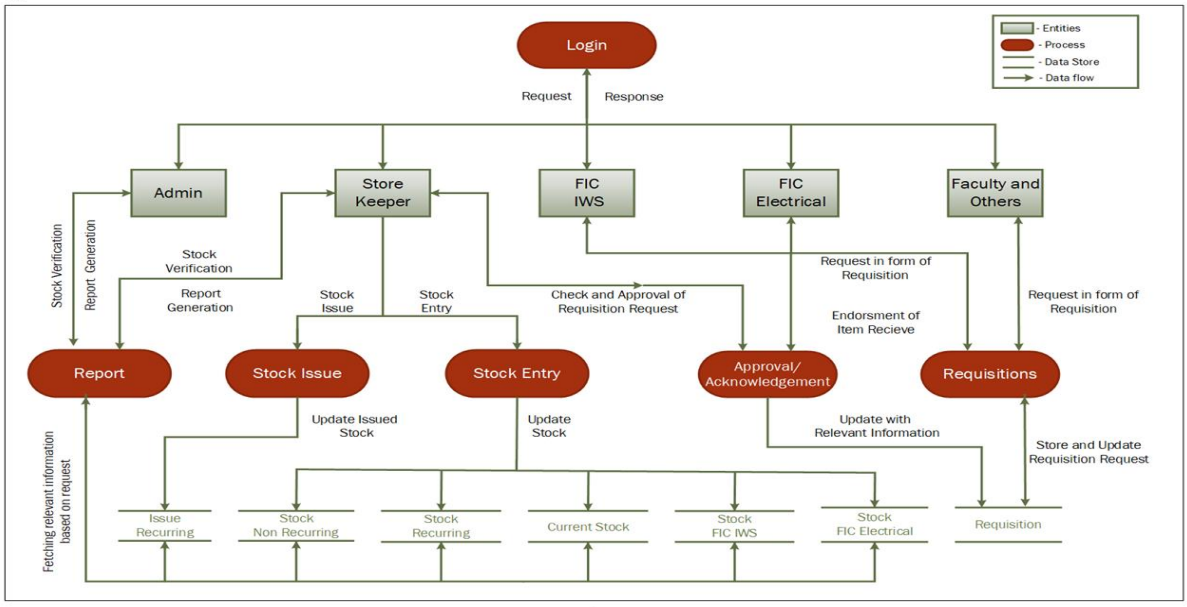
provides information about the outputs and inputs of each entity and the process itself [5, 6]. Figure 4 shows the Data Flow Diagram for this Inventory Management System. Data Flow Diagrams provide a straightforward, efficient way for organizations to understand, perfect, and implement new processes or systems. They are visual representations of the process or system, so they make it easy to understand and prune.

a



Level 0 DFD

b



Level 1 DFD

Fig. 2. *(a) Level 0 DFD (b) Level 1 DFD of Inventory Management System*

The level 0 DFD shown in Figure 2(a) describes the overview of our Inventory Management System. There are five entities, which are Admin, Store Keeper, FIC IWS, FIC Electrical, and Faculty and others. The Admin can verify the store and generate the report of the items.

Store Keeper can perform stock related operations like stock entry and stock issues according to the requirement. FIC IWS and FIC Electrical can make the request in the form of requisition, also they can give the approval of the requisition. Faculty and others can also send the requisition to the store keeper.

The complete overview and functionalities of our Inventory Management System are shown in Figure 2(b), i.e. level 1 DFD which describes more details of our system. Here we saw that in our system login operation can be performed by five types of users, i.e. Admin, Store keeper, FIC IWS, FIC Electrical and Faculty, and others. The Admin has been connected to the report page, so the Admin can verify the stock and also can generate the report from the table. The Store Keeper is connected to Report, Stock Issue, Stock Entry, and Approval. So to issue the stock, Store Keeper needs to update the Issue Recurring table, similarly, according to the requirement of FIC IWS and FIC Electrical, Store Keeper needs to update the Issue Recurring of FIC IWS and Stock and Issue Recurring of FIC Electrical table. Store Keeper also can enter the items in stock by updating the Current Stock, Stock Non Recurring, and Stock Non Recurring table as per requirement. Store Keeper can also give the approval after issuing the item in store. FIC IWS and FIC Electrical can make the request in the form of requisition to the Store Keeper. After getting the approval, Store Keeper checks the availability of the item. If the items are available then the item has been issued, otherwise Store Keeper will purchase the requested item and will issue those items. Finally, the items have been approved by the FIC IWS and FIC Electrical. Faculty and Others can request the items in the form of requisition to the Store Keeper.

ER Diagram of Inventory Management System

An Entity Relationship (ER) Diagram is a type of flowchart that illustrates how entities such as Admin, Store Keeper, and all the faculties relate to each other within a system. ER Diagrams are most often used to design or debug relational databases in the fields of software engineering, business information systems, education, and research [7]. The design phase explains how the developed system operates in terms of hardware, software, and network base. The database used is MySQL because it is one of the database management systems. Table 1 shows all the entities and connections with their table and attributes.

Table A. Stock Non Recurring	**Table B. Stock Recurring**	**Table C. Current Stock**	**Table D. Issue Recurring**
• Accession No. • Accession Date • Detailed Description of Assets/ Item Name • Name of Supplier • Order No. • Order Date • Purchase No. (Optional) • Quantity • Unit Price • Total Price • Progressive Balance of Valuation (Optional) • Communication of Quantity (Optional) • Bin. No. (Optional) • Remarks • Sticker No. • Person Attach	• Sl. No. • Entry Date • Challan No. • Challan Date • Detailed Description/ Item Name • Name of Supplier • Order No. • Order Date • Quantity • Unit Price • Total Price • Reference to Issue Voucher(Date) • Quantity Issued(Optional) • Balance(Optional) • Remarks	• Sl. No. • Item Name • Quantity • Remarks	• Sl. No. • Item Name • Requisition No. • Date of Issue • To Whom Issued • Quantity Issued • Accumulation (Optional) • Ref. if any (Optional) • Remarks

Table E. Stock-Issue-Recurring-IWS	Table F. Stock-Issue-Recurring-Electrical	Table G. Requisition	Table H.Login
• Sl. No. • Requisition No. • Entry Date • Challan No. • Challan Date • Detailed Description • Name of Supplier • Order No. • Order Date • Quantity • Unit Price • Total Price • Reference to Issue Voucher (Date) • Quantity Issued (Optional) • Balance (Optional) • Remarks • Acknowledgement Date	• Sl. No. • Requisition No. • Entry Date • Challan No. • Challan Date • Detailed Description • Name of Supplier • Order No. • Order Date • Quantity • Unit Price • Total Price • Reference to Issue Voucher (Date) • Quantity Issued (Optional) • Balance (Optional) • Remarks • Acknowledgement Date	• Sl. No. • Requisition No. • Indenter • Date of Requisition • Name • Department/Section/ • Cell • Designation • Date of Issue • Item Name • Quantity • Status • Remarks	• Username • Password • Name • Department/Sections/ Cell • Designation

Table 1. *The database and its attributes used in our Inventory Management System.*

In our system software, there are mainly eight database tables: Stock Non Recurring, Stock Recurring, Current Stock, Issue Recurring, Stock and Issue Recurring FIC IWS, Stock Issue Recurring FIC Electrical, Requisition, Login. To store the Asset Ledger of Non-Recurring items, the Stock Non Recurring table has been used given which stores the assets shown in Table 1(A). Table 1(B) used for the Stock Recurring table describes the recurring stock that will update on a regular basis. The Current Stock table describes the recurring stock that has been available in the present as shown in Table1(C). The Issue database table has been used to manage the record of items, issued by the Store Keeper as shown in Table1(D). Table 1(E) and Table 1(F) used for the Stock and Issue Recurring of FIC IWS and FIC Electrical. The Requisition table used to manage the items requests that will come from the faculty as shown in Table1(G). To login in this system, the user needs to provide their username and password, so login table contains Username, Password, Name, Department, and Designation as shown in Table 1(H).

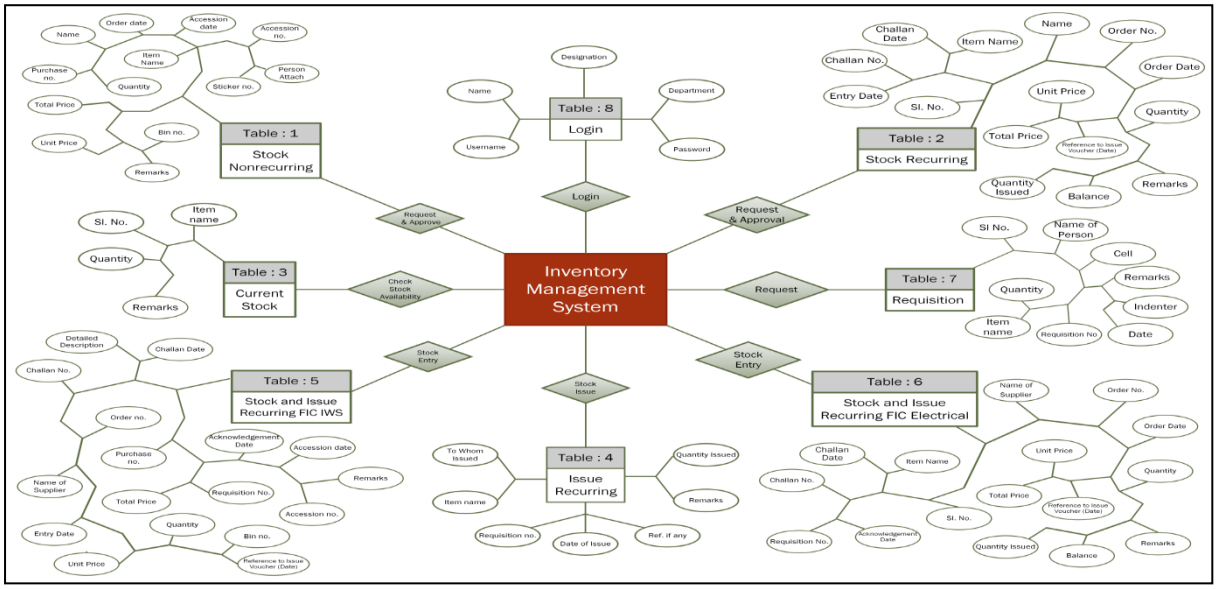


Fig. 3. *ER Diagram of Inventory Management System*

Description of Inventory Management System

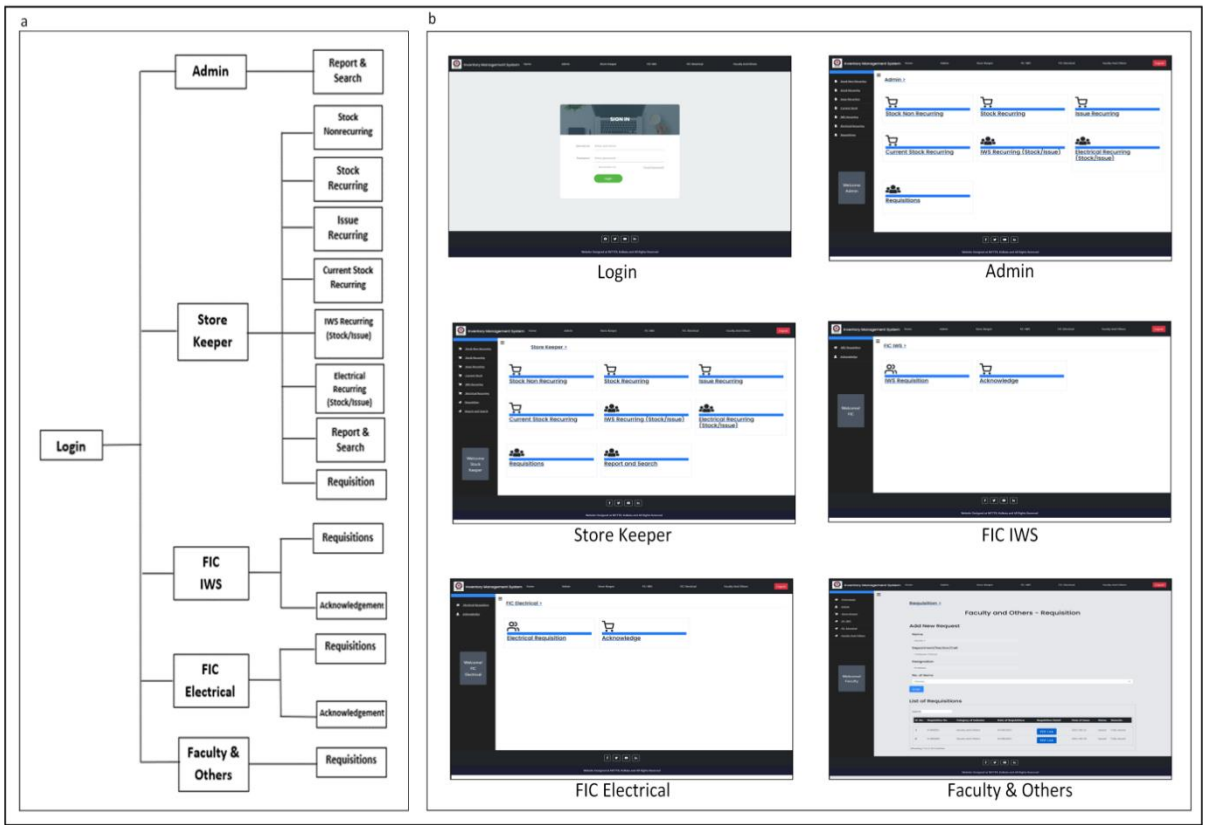


Fig. 4. *(a) Flowchart of Inventory Management System (b) Different scenarios of Inventory Management System*

Login Page

This is the first page of the web inventory system and it ensures the security of complete web application software data. Without authentication, no one can enter and unauthorized access will be denied all the time. Username and password are different for everyone and this information will exist all the time in a specific database.

Admin

After login the user will reach the Admin page where six report options will be visible. Admin can see all the reports and can also print all the reports. These reports are Stock Nonrecurring, Stock Recurring, Issue Recurring, Current Stock, Stock and Issue Recurring FIC IWS, Stock and Issue Recurring FIC Electrical.

Store Keeper

If the user is Store Keeper, then there will be eight options visible after entering this section. Stock Nonrecurring, Stock Recurring, Issue Recurring, Current Stock, Stock and Issue Recurring FIC IWS, Stock and Issue Recurring FIC Electrical, Requisition, Report and Search. Stock Recurring consists of assets entering the system. From Stock Recurring Store Keeper can enter details of purchased items and it will update Current Stock as well. From Issue, Recurring Store Keeper can issue items for each and every faculty. After this process, Current Stock will be updated automatically. From the Current stock, Store Keeper can check whether the requested item is available or not. It shows available and updated stock all the time and it saves a lot of time of Store Keeper. According to that Store Keeper can issue items for requisitions easily. Stock and Issue Recurring FIC IWS is a special faculty case and from here Store Keeper can issue items for IWS faculty. Store Keeper will get a complete stock report and can search items as well. Stock and Issue Recurring FIC Electrical is similar to Stock and Issue Recurring FIC IWS. From here store keeper can issue items for the electrical faculty. Store Keeper will get a complete stock report and can search items as well. From the Requisition section Store Keeper can see all the requests sent by all faculty. According to this

Store Keeper will issue items and check them. After checking specific requests will be approved accordingly. In Report and Search section six report options will be visible to Store Keeper. Store keeper can see all the reports and can also print all the reports according to need.

FIC IWS

Only members of faculty IWS can enter this page. From here they can send requisitions to the store keeper and also, they can see status of their requests. There are two sections IWS Requisition and Approval. From IWS Requisition members of IWS faculty can send requisitions according to their needs and they can also see previous requisition details in this section. Details of requisition will be available in the form of PDF and they can download this PDF anytime. From Approval members of FIC can see the status of their requisitions whether it is pending or approved. They will get information about all issued items from store keeper.

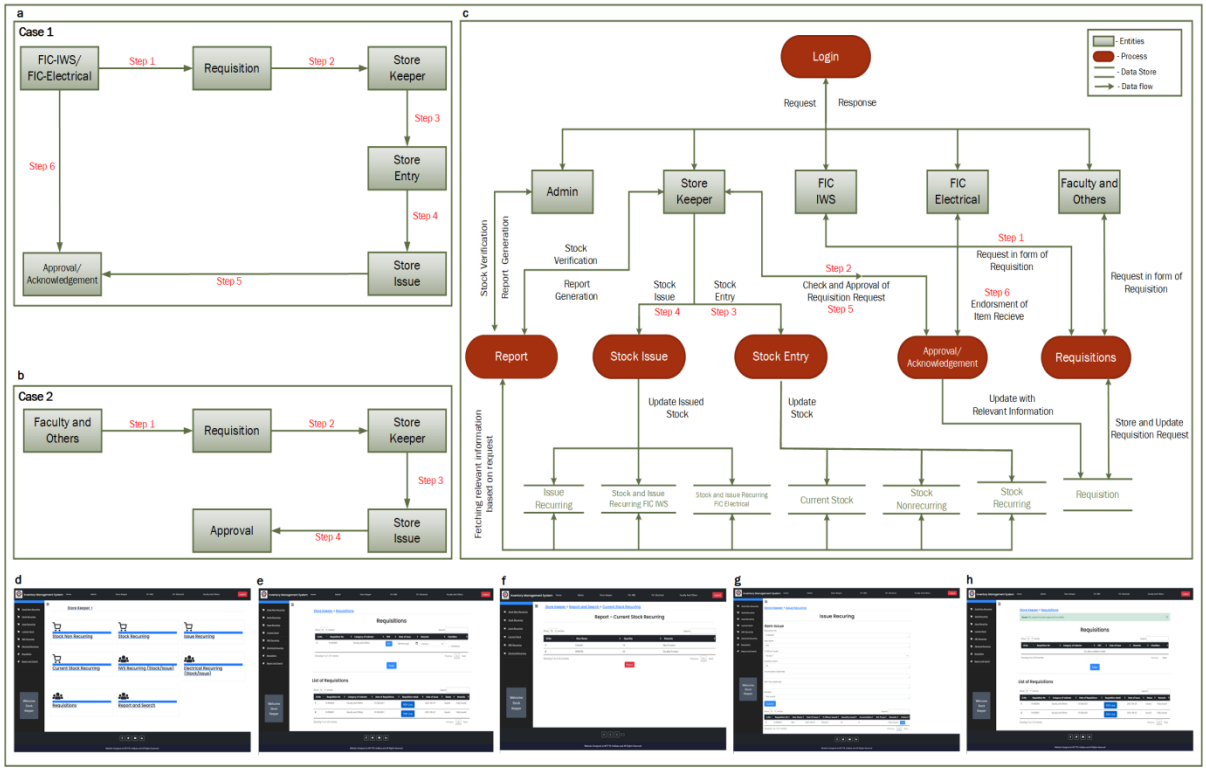


Fig. 5. *(a) Case 1, used to demonstrate the approval of requisition requested by FIC IWS/ FIC Electrical, (b) Case 2, used to demonstrate the approval of requisition requested byFaculty and Others, (c) Level 1used to show the several cases, (d) Web page after login as Store Keeper, (e) Requisition page, (f) Report of current stock recurring, (g) Issue recurring page (h) Store entry of requisition*

FIC Electrical

Only members of the electrical faculty can enter on this page. From here they can send requisitions to the Store Keeper and also, they can see status of their requests. There are two sections Electrical Requisition and Approval. From Electrical Requisition members of electrical faculty can send requisitions according to their need to Store Keeper. They can also see previous requisition details in this section. Details of requisition will be available in the form of PDF and they can download or print that PDF anytime. In Approval section members of electrical faculty can see the status of their requisitions whether it is pending or approved. Here they will get information about all issued items from Store Keeper.

Faculty & Others

After login user will directly reach at Requisition page from where members of each faculty can send requisitions to Store Keeper. Details of the user will attach with requisition automatically from the database after login. User will give only the item name, quantity, remarks and after submitting process will be

complete. So it is very easy to give requisitions from here. They can also see previous requisitions details in this section. Details of requisition will be available in the form of PDF and they can download or print that PDF anytime. Members can see the status of their requisitions whether it is pending or approved.

To understand the functionalities of our application, we considered some cases shown in Figure 5. In case 1 shown in Figure 5 (a) and Figure (c), we demonstrate how the requested items of FIC IWS/ FIC Electrical have been approved by the Store Keeper. In Step 1, FIC IWS/ FIC Electrical requested some items in the form of requisition. In step 2, the requested requisition is sent to Store Keeper where the item has been an entry in step 3. According to the availability of the item, the item has been issued in step 4. If the items are not available, then the store keeper will purchase the requested items to make it available. In step 5, the store keeper approved the requested items by the FIC IWS/ FIC Electrical. Finally, in step 6, FIC IWS/ FIC Electrical provides the endorsement to the store keeper.

In case 2, shown in Figure 5(b), the Faculty and Others can send request in the form of requisition in step 1. In step 2, the requested requisition has been send to Store Keeper. Store Keeper issued the requested items in step 3 and approved that item in step4.

Conclusion

This paper represents the online web application software for the inventory management system. Firstly, the existing inventory management system has been analysed to automate the manual inventory management system. This system will give information regarding stock, suppliers, and sales from time to time. By using this system one can automate all types of inventories. By performing a case study of the manual inventory system of NITTTR Kolkata, we have developed our system to minimize the loopholes of existing manual system. There are five types of users in our system which can perform stock report generation, stock issue, stock entry, approval, and requisition. It is fully secured, easy to use web application. Currently, this system software has been installed in NITTTR Kolkata and being run as a beta version. After getting a positive response from it, the manual inventory software will be replaced with this web application software. It will minimize human mistakes and make a huge effect on the institute's growth and productivity.

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14

Comparative Study of Deep Transfer Learning Techniques for the Detection of COVID-19 using Chest X-Ray Images

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Abstract

With the global spread of the novel coronavirus, detection of COVID-19 becomes an absolute necessity not only to control the spread of the virus but also understand the progression of the virus in a patient diagnosed with COVID-19. While Reverse Chain Reaction Transcription-Polymerase (RT-PCR) is quite accurate in detecting COVID-19, it still lacks in understanding the spread of the novel virus in lungs. Hence, chest X-Ray images of COVID-19 diagnosed patients are taken into consideration in order to understand the progress of the virus. The entire chest X-Rays are evaluated by a group of expert radiologists to identify the COVID-19 patients. Since deep learning techniques have corresponding state-of-the-art models in the field of Biomedical imaging, such techniques can be used for the accurate detection of COVID-19 as well. However, this process of detecting COVID-19 is time consuming. Thus, a limited data has been produced. In this regard, different deep transfer learning techniques can be used to detect the COVID-19 patients using chest X-Ray images. For this purpose, ResNet101, ResNet50, VGG19, DenseNet201, EfficientNetB0, Xception and InceptionV3 are used with their pretrained models of around 10000 chest X-Ray images. As a result, the highest average aggregated scores for ResNet101 and ResNet50 are 96.3 and 96.4. Moreover, the results are also reported in the form of Receiving Operating Characteristics curve and through confusion matrix.

Keywords: Chest X-Ray, COVID-19, Deep Transfer Learning, SARS-CoV-2.

Introduction

SARS-CoV-2 is the third virus of the SARS family, the first and the second being SARS-CoV-1 and MERS-COV. Unlike the earlier viruses, SARS-CoV-2 is highly contagious and World Health Organisation (W.H.O) declared it as a pandemic on March, 2020. From recent studies, it is inferred that COVID-19, the disease caused by SARS-CoV-2, has a fatal

effect on the lungs and an infected person may suffer from chest pain and even suffocation due to lack of oxygen that can led to the eventual death of the patient. Hence, this makes the early detection of COVID-19 a necessity for not only isolating the COVID-19 patient but also quickly begin the treatment process. The detection of COVID-19 using radiomics feature can be the process for its early detection. However, this process is quite time consuming and prone to human error as a group of expert radiologists analyse the chest X-Ray images before confirming the presence of COVID-19 in the patient.

Recently, deep learning techniques have been used in image analysis and have produced competitive results. With such success of deep learning techniques, they are used in biomedical imaging and have been a crucial part in Computer-aided Diagnosed (CAD) tools which help the radiologists to quickly and effectively detect any anomalies present in the chest X-Ray images. This makes deep learning technique the key for the quick detection of COVID-19 using radiomics features. Deep learning techniques consist of different computational layers which help present a spatial feature representation of the given data. In between these layers, activation layers are used along with other parameters to make the technique more robust in correctly predicting the anomalies. With such high computational complexity, deep learning techniques require a large amount of data to clearly understand the feature of the given data. With the limited data of COVID-19, deep learning techniques lack in producing robust results which can help detect COVID-19. Hence, deep transfer learning techniques can be used since these techniques can produce robust results on limited data since they contain pretrained weights of the model that are trained on 1000 class problem of ImageNet. This use of pretrained weights helps the deep learning technique to have an enriched spatial feature representation.

This study focuses on the comparison amongst seven deep transfer learning techniques like ResNet101, ResNet50, VGG19, DenseNet201, EfficientNetB0, Xception and InceptionV3 which are used with their pretrained models of around 10000 chest X-Ray images for the detection of COVID-19 patients. Consequently, the highest average aggregated scores for ResNet101 and ResNet50 are 96.3 and 96.4. Moreover, the results are also reported in form of Receiving Operating Characteristics curve and through confusion matrix. The remaining part of the study is structured as follows. Section 2 provides a review on the recent work for the detection of COVID-19 chest X-Ray images Section 3 discusses the architecture of each of the seven Deep transfer learning techniques. Section 4 shows the comparative result of these techniques out of which ResNet101 and ResNet50 outperform the other techniques. Finally, conclusion with future scope is discussed in Section 5.

Literature Review

The high reproductive number as well as the emergence of different variants of SARS-CoV-2 make the early detection of the novel virus necessary in order to control the spread of the virus. Since deep learning provides a quick and accurate result in Computer Aided Detection (CAD) tools which are then used by radiologists for detecting anomaly, they become the foremost technique to detect COVID-19 anomalies in chest X-Ray images. With this in hand, Khan et. al. [1] proposed CoroNet which uses the pretrained weights of extreme version of Inception (Xception) model [2] as backbone in order to identify and classify COVID-19 related chest X-Ray images from other pneumonia related chest-Xray images. Due to the limited data for COVID-19, the model was trained on two publicly available datasets. The first data provided by Cohen et. al. [3] consists of 290 COVID-19 chest X-Ray images. The second data was provided by Kaggle[1] repository which consists of 1203 normal chest X-Ray images with 660 bacterial and 931 viral pneumonia chest X-Ray images. The architecture of CoroNet consists of Xception model along with residual connections and fully connected layers for the classification of chest X-Ray images. Xception model is a 71-layer deep Convolution Neural Network (CNN) model which uses Depthwise Separable Convolution layers since these layers

focus on pointwise convolution operations that produce refined spatial information of the image with less computational complexity. The residual connections in between the depthwise separable convolution layers help in further enhancing the contextual information by providing any loss of spatial information from the low-level layers to the high-level layers of the model. CoroNet being highly robust still lacked in utilizing the data augmentation techniques to further produce more robust results. This was utilized by Zhang et al. [4]. They proposed COVID19XrayNet model which uses the pretrained ResNet-34 model as the backbone of the proposed model. They perform two step transfer learning technique in order to classify COVID-19 chest X-Ray images. The COVID19XrayNet was trained on two datasets, where the first one was obtained from Kermany et al. [5] which consists of 5860 chest X-Ray images containing pneumonia. The other dataset was obtained from Cohen et. al. [3] which consists of 290 COVID-19 chest X-Ray images. Since both the datasets contained a very limited data, they performed random cropping, random rotation, random horizontal and vertical flip as data augmentation techniques which help in creating ample amount of COVID-19 chest X-Ray images. The ResNet-34 model was pretrained on ImageNet and the deep layers of the model lacked the contextual knowledge for chest X-Ray images. Hence, they proposed Feature Smoothing layer (FSL) in between ResNet-34 architecture which helped in smoothing the pretrained gradients in order to capture the new features of the chest X-Ray images. The last few fully connected layers of the ResNet-34 model were replaced by a novel Feature Extraction layer (FEL) that help produce an abstracted feature representation of the final convolution layer. The first stage of the transfer learning technique involved the training of the COVID19 XrayNet on pneumonia based chest X-Ray images which helped in understanding the features of X-Ray Images. This pretrained model was then fine-tuned and used to identify COVID-19 chest X-Ray images. A similar work was proposed by Alhudhaif et al. [6] which used data augmentation techniques on the chest X-Ray images and show a comparative result of three pretrained model which include: DenseNet-201, ResNet-18 and SqueezeNet. The pretrained models were trained and evaluated on Cohen et al. [3] and Wang et al. [7] which produced 1218 chest X-Ray images out of which 368 were of COVID-19 pneumonia while 850 belonged to other pneumonia cases. Since the COVID-19 pneumonia chest X-Ray images were quite low, so to prevent data imbalance, image augmentation were performed on the COVID-19 chest X-Ray images after which normalization was performed. Gradient-weighted class activation mapping (Grad-CAM) approach was implemented since it helps visualize the critical ROIs which the pretrained model focuses on the Chest X-Ray image. Out of all the three pretrained models, DenseNet-201 outperformed the other models by attaining an accuracy of 94.96%.

In all the studies, a single pretrained model was used to determine the COVID-19 ROIs in chest X-Ray image, although a fusion of multiple pretrained models would create a more generalized and accurate prediction. Chouhan et al. [8] proposed an ensemble of pretrained CNN models which include AlexNet, DenseNet-121, InceptionV3, ResNet-18 and GoogLeNet. The proposed ensemble model was trained on dataset from Guangzhou Women and Children's Medical Center which consists of 1346 normal chest X-Ray images, 2538 bacterial pneumonia and 1345 viral pneumonia images. Due to such high complex CNN models, data augmentation techniques were introduced to counterpart the data sufficiency for training these models. The data augmentation techniques include random cropping and random horizontal flip along with a varying intensity of images. The ensemble model uses the majority voting technique for the final prediction of the class to which the chest X-Ray image belongs to. Since all the above work considered the radiographical features, Chaudhary et al. [9] proposed a novel work which decomposes the chest X-Ray images into sub-band images (SBIs) using the Fourier-Bassel series expansion based decomposition (FBSED) method. These SBIs were then provided to the pretrained CNNs for

detection of COVID-19. The database for this proposed FBSED method were obtained from Cohen et al. [3] and Kaggle[2] repository which provided 1446 chest X-Ray images out of which 482 belonged to COVID-19, pneumonia and normal respectively. The preprocessing of the data includes normalization followed by contrast enhancement using CLAHE method [10]. According to frequency, FBSED method decomposes the chest X-Ray image into SBIs. From each SBI, deep features are then extracted by the five pretrained CNNs which include ResNet-50, AlexNet, Inception-ResNet-v2, NASNet and EfficientNet. Out of all the pretrained CNNs, ResNet-50 and AlexNet performed the best with an accuracy of 100%. As most of the aforementioned works have considered the pretrained network of the well-known deep learning techniques, thus we have conducted this comparative study using deep learning techniques with the concept of transfer learning.

Methodology

The limited data for COVID-19 chest X-Ray images create challenges for the deep learning techniques to achieve state-of-the-art results. Hence, many focus on deep transfer learning approaches due to their robust and precise results when limited data are present. Transfer learning is the process of utilizing enhanced and highly accurate weights of a model and is trained on a completely different dataset considering the limited data by modifying the last few layers of the model. This use of pretrained weights of the model makes the model generalize effectively for limited data.

With Residual blocks being proposed by He et al. [11], the ResNet models have achieved great efficacy in image analysis due to the capturing of contextual information from the shallow layers and provide the lost information to the deeper layers of the model. For this study, we have used ResNet101 and ResNet50 which are shown in Figure 1(a) and 1(b) respectively.

VGG19 is another robust deep learning technique provided by Simonyan et al. [12] that helps capture the significant features present in an image. VGG19 is a 19-layer CNN model which consists of convolution and pooling layers which can be seen in Figure 1(c).

Just like Residual blocks, a more collective information block was proposed by Haung et al. [13] which was termed as Dense blocks. Dense blocks capture the contextual information of all the preceding shallow layers by adding and concatenating them all and provide it to the following deeper layers of the model, thereby making the Dense blocks quite computationally efficient. For this study, DenseNet201 were used which is shown in Figure 1(d).

EfficientNetB0 proposed by Tan et al [14] contains novel MBConv blocks which make the structure of the model efficient for precise feature extraction. MBConv block consists of Squeeze and Excitation (SE) blocks which give weightage to each of the channel present in the spatial feature representation. Along with it a novel activation Swish were used which is the product of linear and sigmoid activation functions. These characteristics of the EfficientNetB0 makes it quite robust and hence is used for this study. The structure of the model is shown in Figure 1(e).

Xception model proposed by Chollet et al. [15] used modified Depthwise Separable Convolution layers which contained pointwise convolution followed by SeparableConv blocks. This made the use of different receptive fields for finding the precise spatial feature representation for the image features. The structure of the Xception model is shown in Figure 1(f).

InceptionV3 proposed by Szgedy et al [16] introduced the multiple filter sized convolution layers that help capture image features using different receptive field. This made the model wider due to the addition of different convolution paths. The structure of the model is shown in Figure 1(g).

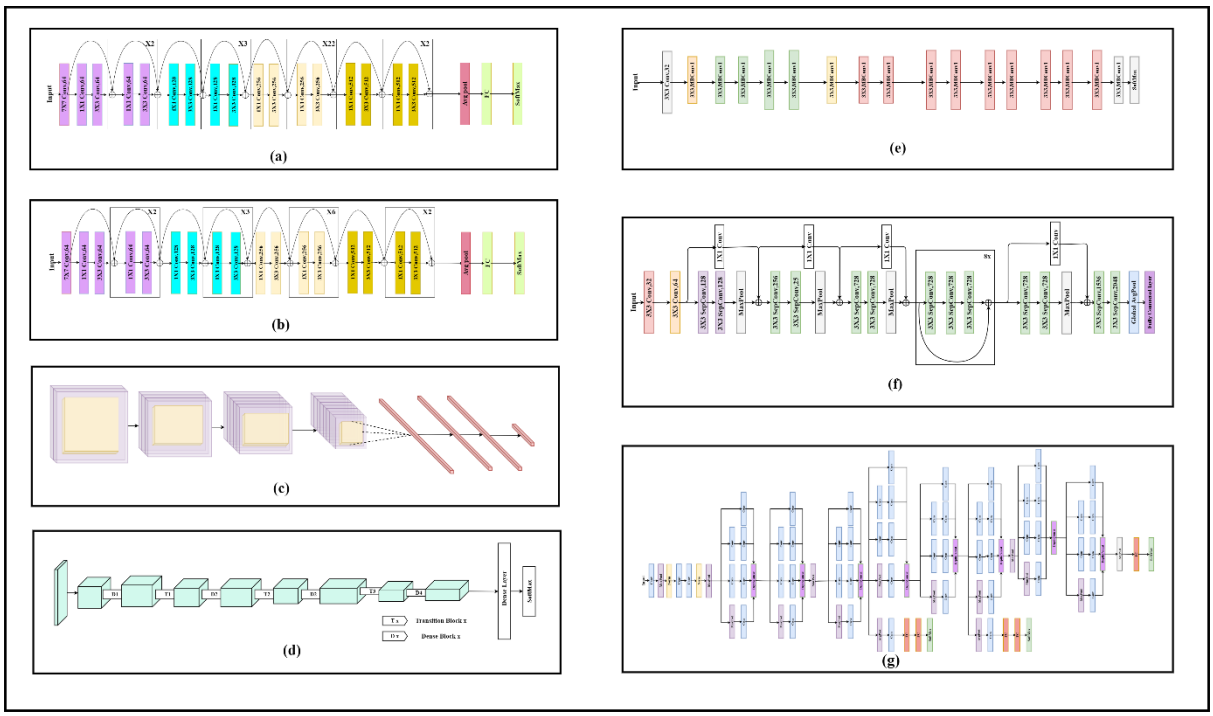

Fig. 1. *Different Deep Transfer Learning Techniques (a) ResNet101, (b) ResNet50, (c) VGG19, (d) DenseNet201, (e) EfficientNetB0, (f) Xception, (f) InceptionV3*

Experimental Setup

Datasets

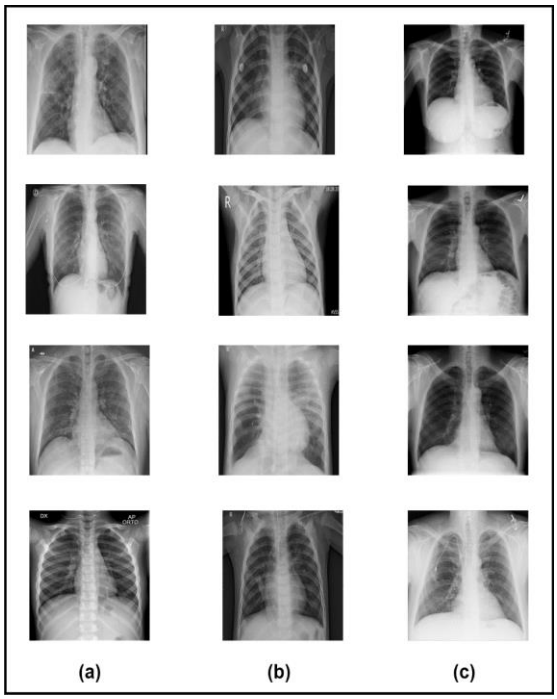

Fig. 2. *Samples of Chest X-Ray Images for (a) COVID-19, (b) Viral Pneumonia and (c) Normal*

For the comparative study, the COVID-19 chest X-Ray image datasets are collected from Chowdhury et al. [17] and Rahman et al. [18], which contain 3616 COVID-19 chest X-Ray images, 1345 viral pneumonia images and 10192 normal chest X-Ray images. In our study, 3616 COVID-19, 1345 viral pneumonia and 5000 out of 10192 normal chest X-Ray images are taken, thereby making the total dataset size equal to 9961. The dataset is provided by researchers from Qatar University and Dhaka University in collaboration with the expert radiologists and doctors from Pakistan and Malaysia. Figure 2 shows the sample from the different classes of chest X-Ray images present in the dataset.

Performance Metrics

To have a comparative performance evaluation of the different deep transfer learning techniques for detection of COVID-19 chest X-Ray images, we employ different standard performance metrics such as accuracy (ACC) , specificity (SPEC), sensitivity (SEN) or recall, precision and F1-score (F1) which are shown in Equations 1 to 5. Accuracy, as shown in Equation 1, is used to measure the fraction of correctly classified chest X-Ray image over the total number of chest X-Ray images. Specificity or True Negative Rate (TNR) is the measure of the correctly classified negative labels and is defined in Equation 2. Sensitivity or True Positive Rate (TPR) is the measure of class label that were correctly predicted and is

shown in Equation 3. Precision depicts the fraction of correctly classified labels and is shown in Equation 4. F1 score is the weighted average or harmonic mean of precision and recall and is shown in Equation 5.

$$Accuracy = \frac{TP+TN}{TP+TN+FP+FN} \times 100 \quad (1)$$

$$Specificity = \frac{TN}{TN+FP} \times 100 \quad (2)$$

$$Recall = \frac{TP}{TP+FN} \times 100 \quad (3)$$

$$Precision = \frac{TP}{TP+FP} \times 100 \quad (4)$$

$$F1\ Score = 2 \times \frac{Precision \times Recall}{Precision+Recall} \times 100 \quad (5)$$

Here, TP is the number of labels correctly predicted, TN is the number of negative labels that are correctly predicted, FP is the number of negative labels that are incorrectly predicted as positive labels while FN is the number of positive labels that are predicted as negatives.

Parameter Setting

To determine the performance of each of the different deep transfer learning techniques, 60% of the chest X-Ray images are selected randomly as training dataset, 10% of the chest X-Ray images are chosen for creating the validation dataset and the remaining 30% of the chest X-Ray images are used as test dataset. There are no common images among any of the sets. All the different deep learning techniques have their default hyper-parameters with weights trained on ImageNet dataset. All the images are scaled to 224X224 pixels for the different deep learning techniques following which the normalization of the images are performed. Each of the different deep learning techniques are implemented in python using Keras package with Tensorflow backend on Python 3 Google Compute Engine backend (GPU) provided by Google Colaboratory.

Deep Transfer Learning Techniques	Accuracy	Sensitivity	Specificity	Precision	F1-Score	Average Aggregate Score
ResNet101	97.3	96.3	98.0	94.7	95.3	96.3
ResNet50	97.3	95.0	97.7	96.3	95.7	96.4
VGG19	97.0	95.7	97.3	95.7	95.7	96.2
DenseNet201	93.0	91.3	94.7	90.0	87.0	91.2
EfficientNetB0	87.7	83.0	90.0	82.7	81.0	84.9
Xception	92.0	85.3	91.0	85.3	84.7	87.6
InceptionV3	90.3	86.7	91.3	84.7	85.7	87.7

Table 1. *The overall performance of different Deep Transfer Learning Techniques on Chest X-Ray Images for Test dataset*

5. Results

Each of the different deep transfer learning techniques are first evaluated on the validation dataset of the chest X-Ray images on the basis of classification accuracy and is shown in Figure 3. From Figure 3, it is inferred that ResNet101 after training for 10 epochs, outperformed all the other different techniques. From Table 1 as well, it is inferred that both ResNet101 and ResNet50 are able to correctly detect the COVID-19 chest X-Ray images on test dataset by acquiring a classification accuracy of 97% while sensitivity, specificity, precision and F1-score are 96.3%, 98%, 94.7%, 95.3%, 95%, 97.7%, 96.3% and 95.3% respectively. Considering the performance metrics of each of the deep transfer learning techniques, an average aggregated scoring method similar to [19] is established for all the different techniques as shown in Figure 4. This aggregated score further helps in determining the overall efficacy of all the different techniques.

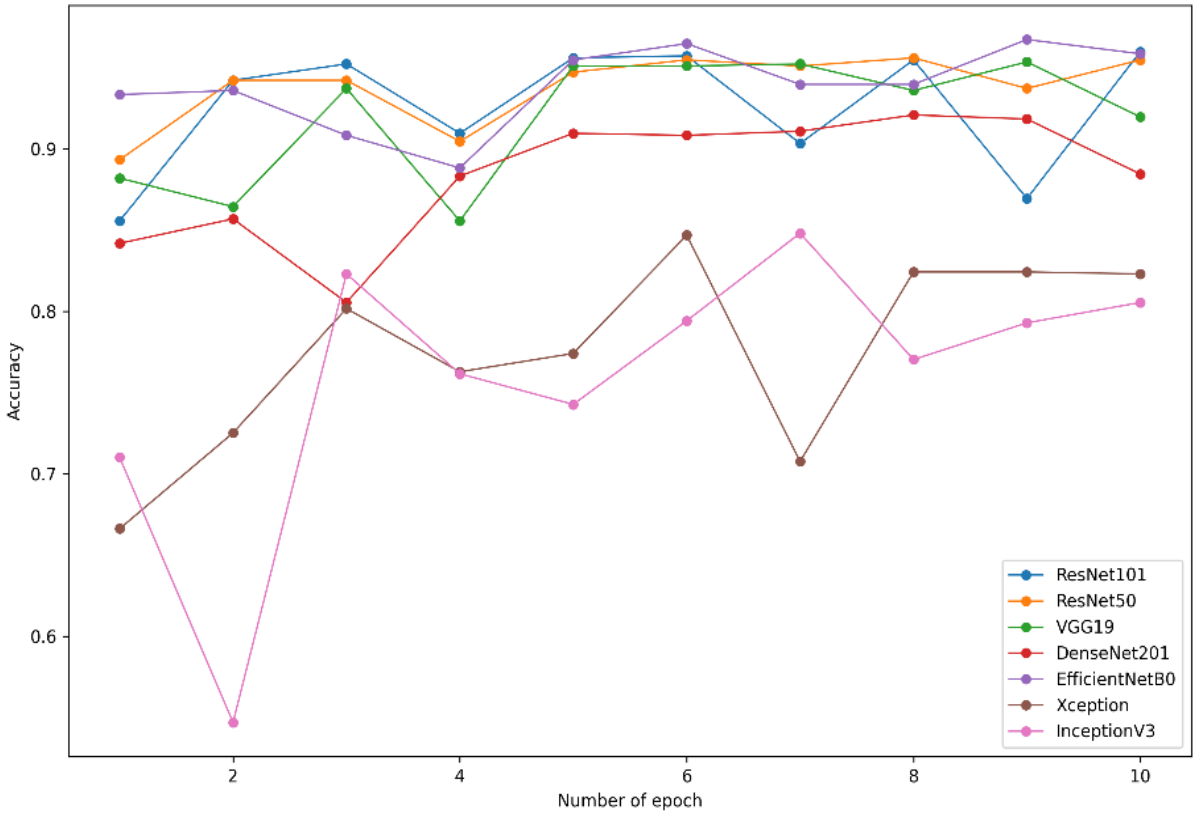

Fig.3. *Classification accuracy of different Deep Transfer Learning Techniques on validation dataset of Chest X-Ray images*

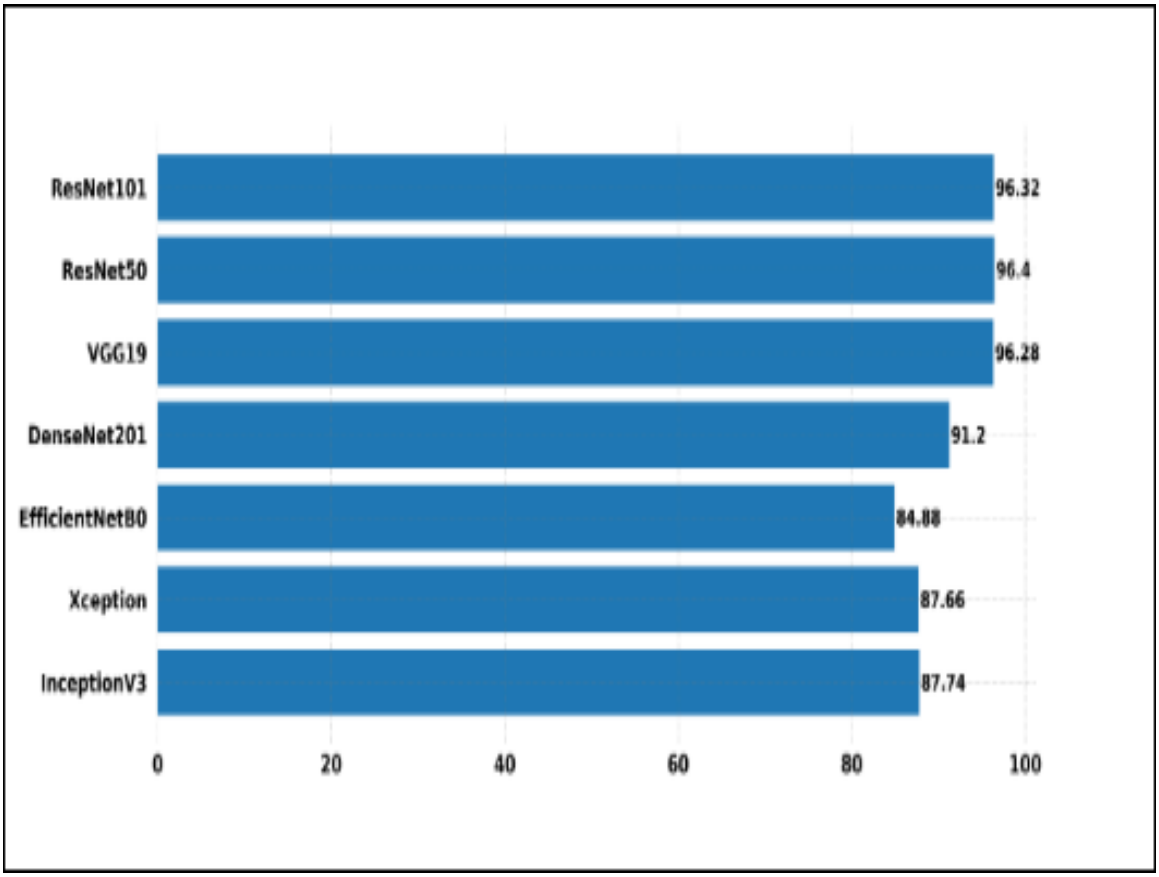

Fig. 4. *Average aggregated score of the different Deep Transfer Learning Techniques on Chest X-Ray images for Test dataset*

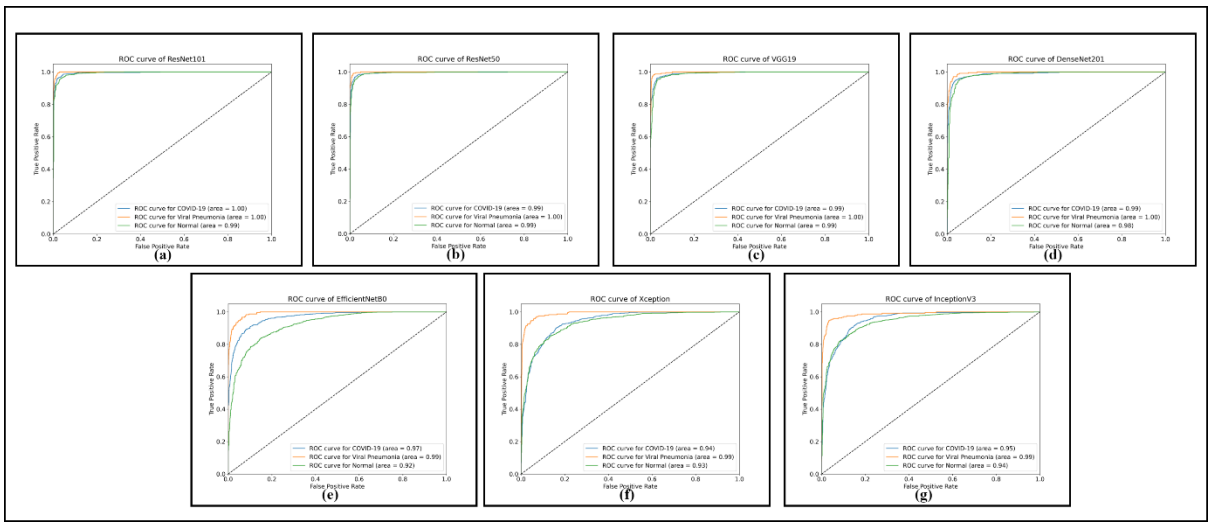

Fig. 5. *Comparison of different Deep transfer Learning Techniques based on Receiver Operating Characteristics (ROC) curve for (a) ResNet101, (b) ResNet50, (c) VGG19, (d) DenseNet201, (e) EfficientNetB0, (f) Xception, (g) InceptionV3 on Chest X-Ray images for Test dataset*

With the class-wise performance metrics in hand, Receiver Operating Characteristics (ROC) curves are plotted as shown in Figure 5 to graphically explain the diagnostic capability of each of the deep transfer learning techniques on the chest X-Ray images. A final comparison of the different techniques is reported using the confusion matrix to understand the performances of the techniques. This is demonstrated in Figure 6. All these performance metrics and parameters state that ResNet101 and ResNet50 techniques outperform all the rest of the deep transfer learning techniques and they have very similar performance.

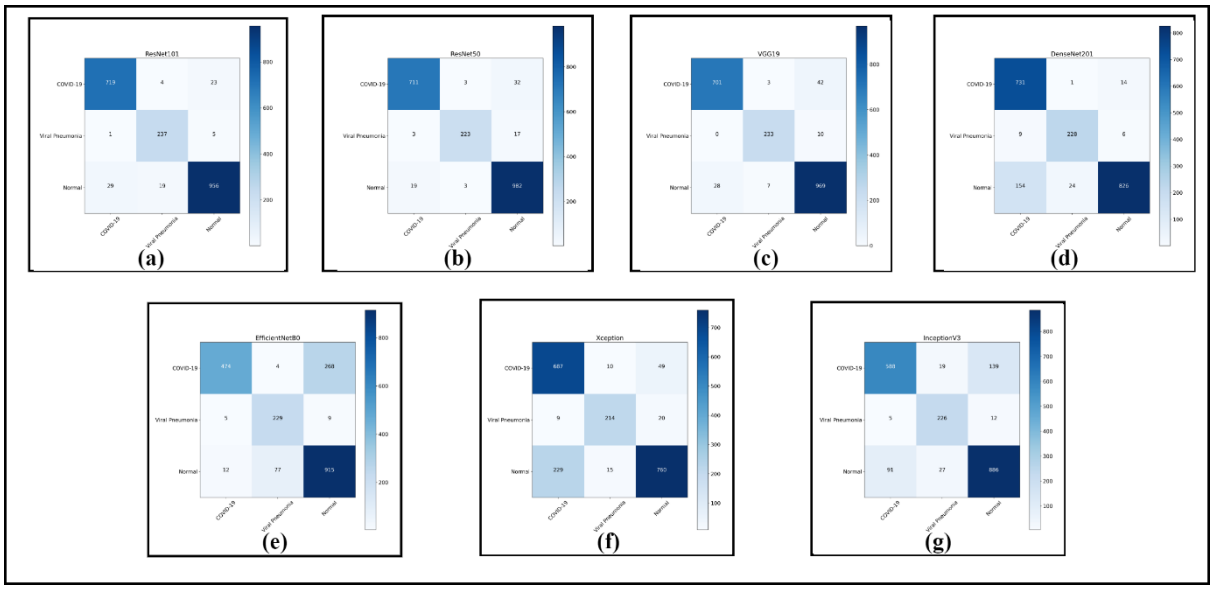

Fig. 6. *Confusion Matrix (CM) of each Deep transfer learning Technique for (a) ResNet101, (b) ResNet50, (c) VGG19, (d) DenseNet201, (e) EfficientNetB0, (f) Xception, (g) InceptionV3 on Chest X-Ray images for Test dataset*

Conclusion

This paper provides a comparative study of the detection of COVID-19 patients using chest X-Ray images. Pre-processing such as image normalization and resizing are used to create a better visual image feature for the different deep transfer learning techniques so that they can produce more robust results. Different standard performance evaluation metrics are used to evaluate and compare different such techniques like ResNet101, ResNet50, VGG19, DenseNet201, EfficientNetB0, Xception and InceptionV3 which are used with their

pretrained models of around 10000 chest X-Ray images. As a result, the highest average aggregated scores for ResNet101 and ResNet50 are respectively 96.3 and 96.4. Furthermore, the results are reported in form of Receiving Operating Characteristics curve and through confusion matrix. For future scope, we aim on using more pretrained techniques with increased dataset in order to boost the efficacy of the techniques.

Acknowledgements

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SHORT BIO-SKETCH OF EDITORS

Prof. Debi Prasad Mishra

Prof. Debi Prasad Mishra is the present Director of National Institute of Technical Teachers' training & Research (NITTTR), Kolkata under MoE, GoI. He has been actively involved in teaching in higher education for more than 25 years now. He held the prestigious position of 'Former Chair Professor, Indian Oil Golden Jubilee Professional Chair, IIT, Kanpur'. He has a rich experience in research in Combustion and Propulsion. He has been an active researcher in the fields of ancient Indian education and ancient STEM of India. He believes in and propagates humanistic model of education. He has published more than 238 research papers in International/National Journals. He has undertaken more than 38 research and consultancy projects from various agencies, research labs and industries.

Prof. Mishra has developed 6 online courses under SWAYAM Platform, a national initiative of MHRD. Besides this, he has designed and developed a unique MOOC course, "Introduction to Ancient Indian Technology" on SWAYAM platform of NPTEL. He has published three edited books and developed 10 lectures in 'Ancient Indian Science and Technology' on Swayamprava TV. Prof. Debi Prasad Mishra is a very popular motivational speaker.

Dr. Habiba Hussain

Doctorate in Education, having a teaching and training experience of more than two decades, Habiba Hussain is currently in the profession of training of technical teachers across the country. At present, she is working as an Associate Professor in the department of Education & Management at National Institute of Technical Teachers' Training & Research (NITTTR), Kolkata, under MoE, GoI. She has also trained Master trainers for Vocational education and Skill development programmes under NSQF (under skill development mission). In the field of research and extension services, Habiba Hussain has contributed in several areas, has book chapters, conference & journal papers to her credit. She has delivered invited lectures at several forums, and has also developed video lectures under MOOCs.

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ABOUT NITTTR KOLKATA

National Institute of Technical Teachers' Training & Research (NITTTR), Kolkata was established in 1965 as Technical Teachers' Training Institute, Calcutta. This was one of the four such Institutes (other three being at Chandigarh, Bhopal and Chennai) established by the Department of Education, Govt. of India as fully centrally funded Autonomous Institution. The primary focus of the Institute is to provide in-service training to the teachers and staff of Degree and Diploma level technical institutions and conduct activities related to the quality improvement of the technical education system of the country.

NITTTR, Kolkata has been actively involved in improving the quality of technical education system in various states including those in the north-east through innovative academic interventions, providing assistance to policy makers at the national and state levels, formulation of educational plans, projects and their implementation in the fast changing scenario. The focal activities of the institute are short term training, curriculum development, learning resources development, research in the field of technical education system, educational management and extension services. Besides, the institute is also offering AICTE approved M. Tech. degree programmes in several branches of engineering.

About the conference

The aim of this conference was to bring together researchers, academicians, policy makers, industrialists and other stakeholders to a common platform so that different strategies to improve the overall technical education of the country can be explored. The principal focus would be to rethink engineering education in a global way.

Objectives

- To examine diverse branches of Engineering education promoting innovation
- To develop a vision for Engineering Education with appropriate R & D
- To analyse the challenges as also opportunities so as to bring reforms in Engineering Education
- To explore new technologies fostering improved teaching methodologies
- To integrate quality in the process and product for global recognition

Conference themes

- Reforms in Engineering Education
- Quality assurance in Engineering Education
- R & D in Engineering Education
- Prospects & Challenges in Engineering Education
- Use of technology in Engineering Education
- Engineering Informatics
- Paradigm shift in Engineering Education