Re imaging of Engineering Education Model to re-invent Next Gen engineers

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Abstract: Today, there is a need to re imagine engineering education wherein the graduates should possess sound engineering knowledge and be globally employable with leadership qualities, ethical attitude, lifelong learning and social sensitivity. To make TCET an institute of national relevance; a lot of strategic shifts have been carried out over the years from its journey of an affiliated institute to being autonomous currently. We have planned, executed and monitored Choice Based Credit Grading System with Holistic Student Development (HSD) model as per AICTE model curriculum with the objective of making the budding engineers globally competent, locally relevant and skill oriented. The model has been designed taking inputs from reputed institutions abroad, feedback from stakeholders and a lot of brainstorming among experienced faculty members. The results of deploying this model on TCET students are promising and thus we propose the same to the outside world. The paper presents the efforts laid down over the years and the model in detail. We further propose a model with pointers from National Education Policy 2020 focussing Holistic and Multidisciplinary education, multiple exit options, Academic Bank of credit and option to obtain Degree with research alongwith experiential learning. We shall measure the proposed model on parameters as quality offerings, diversity and freedom of choice in offerings. Currently the measurements are presented in the form of survey results from stakeholders as the ones undergoing autonomy, batches prior to autonomy and the faculty members.

Keywords: Holistic Student Development, AICTE model curriculum, National Education Policy 2020, Internship, Flexibility in choice of electives

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1. Introduction

Statistics in a Nasscom report estimate that out of 3 million joining IT workforce only 25% of the engineering graduates are employable (Nair 2020). Further (IUCEEITF 2017) has stated the following issues:

- Supply of engineering graduates exceeds our current national demand, thus there is a need to raise the talent of engineering graduates and make them industry ready.
- Only 15% of the engineering programmes are NBA accredited.
- There is a need to ensure that at least 75% of the students get industry exposure in form of summer internships.
- Only a third of the engineering graduates from Tier 2 and 3 colleges are gainfully employed.

In the initial years of the institute being affiliated by UoM, Student progression w.r.t. academic results, placement and higher studies was a concern. Gradually the results started meeting the benchmark and ISO requirements by proper planning, execution and monitoring of structured and guided teaching learning process. With maturity of institute and its departments, Holistic Students development activities were introduced in the form of non-credit courses. At the initial stage planning, execution and monitoring was a concern since credits were not associated with the same. But slowly when students understood the need and faculty matured in the conduct, HSD was integrated into the curriculum under autonomous syllabus design. The final outcome of any professional course is in the form of quality results, placements in product and dream companies and admission to renowned higher education institutions.

A graduate for it's all round development needs to be groomed w.r.t. academic, co-curricular and extra-curricular activities. Institutions having qualified and experienced faculty are able to meet the academic requirements well. But industry needs professionals who are well groomed in terms of leadership qualities, team work, communication, problem solving skills, modern tool usage, an attitude for lifelong learning and having ethical attitude and social sensitivity.

Being a minority institute, the intake of students is of varied category in terms of the basic education and mother tongue. Hence, it has been challenging for faculty to bring these diversified entrants at the same level. Even students of different disciplines mostly get jobs in IT industry. This

becomes a challenge for both IT and non IT branches at par. Recruiters who provide bulk placements lack in hands on projects to be handed over to the fresh employees. Employer's feedback when analysed states that these fresh graduates lack professional etiquettes and skills. The current scenario demands dual degree and the graduates of self-financed private institutes lack general aptitude and verbal skills to be able to get admitted into reputed institutions for further studies. The current generation is targeting money over knowledge. Past statistic shows that students' personality improvement happens through participation in Co-curricular and extracurricular activities. Further, conducting these activities inculcates soft skills as leadership, team building, etc. Thus, Holistic student development is the need of the hour for better student progression.

2. Literature Survey

Institutions need to have excellent faculty and use innovative teaching methodology, organize internships and industrial visits, provide experiential learning through group assignments in order to support students who look forward to pursue higher studies (Ahuja 2017). (Ríosa, Cazorlaa, Puentea, Yagüea 2010) project collaborative learning by integration of academic delivery with research and state the importance of self learning. U.S. National Academy of Engineering (NAE 2004) have undergone a study which states that "Engineers will be expected to provide solutions that lessen the risk of complete failure and at the same time prepare backup solutions that enable rapid recovery, reconstruction and deployment".

6 months internship is made mandatory for engineering students by AICTE (jagranjosh 2018). To improve the employability prospects, engineering students across the country will have to undergo at least three mandatory internships during their course from this academic year. It will be the responsibility of colleges to ensure internship for students (hindustantimes 2017). (Parashar 2012) conducted a survey which states internship as experiential learning. It seems to be of value as it connects concepts learnt to hands on experience thus contributing to students' personality and professional etiquettes. Further, AICTE chairman (ToI 2017, Bengaluru) states that "internship is mandatory for engineering graduates – this move will help students get jobs." Moreover as per (ToI 2017 Chennai), AICTE states to "cut down theory and focus on practice". Only a percent of engineering students undergo internships.

As per (ToI 2017), the quality of graduates is low leading to average employment due to following reasons:

1. Low quality physical infrastructure
2. Deficiency of experienced teachers
3. Outdated course structure and content
4. Shortage of Research activities
5. Low training quality
6. Unproductive linkages in industry

Learning based on project building with specified roles of facilitators defining the strong points and weaknesses (So, Kim, 2009). The curriculum should be designed so that it bridges industry institute gap (Lang, Cruse, McVey, McMasters 1999). The results of survey by (Chandrasekaran, Stojcevski, Littlefair, Joordens 2013) demonstrate that students are interested in project based learning and this lets them to get involved with applying the concepts they have learnt to real life problems. Learning through experimentation, by working on projects and internships is proposed by (Felder, Brent, 2005). Elective courses play an important role in students' professional and personal development by integrating knowledge of multiple subjects (Movchan L., Zarishniak I. 2017).

Several employability skills have been perceived as employers like communication, team work, problem solving, leadership and interpersonal to help graduates reach greater heights in their career (Nisha, S. M, Rajasekaran, V. 2018). Transition from university to employment has personal, societal and economic implications, thus curricular and co curricular activities influence this transition. Extension activities in higher education promote pathways for life long learning (de Gusmão C. M. G. 2020).

Major reforms in higher education as 50% gross enrolment ratio, flexibility of subjects, multiple entry/exit, UG programme for ¾ years, PG programme for ½ year, integrated degree, credit transfer and multidisciplinary education are approved in New Education Policy (timesofindia 2020). Holistic education focusses on wholeness promoting different aspects of individual as intellect, spirituality, emotional wellbeing, societal perspectives, etc. (Mahmoudi S., Jafari E., Nasrabadi H., A., Liaghatdar M. J. 2012). ICT engineering students understand client requirements while solving a complex task by looking at the big picture based on interaction with design and business students. Employers prefer students who have experienced experiential learning in higher educational institutions but this has not been incorporated much in Higher education institutions because of the classroom structure, size, time, etc. (Wurdinger, S., Allison, P. 2017). (Park H., Choi J., Kim J. 2019) state that Academic Credit Bank System operating in Republic of Korea since 1998 is limited w.r.t. social recognition Kovalchuk S., Ghali M., Klassen M., Reeve D., Sacks R. (2017).

3. Proposed Model

TCET has experienced and highly qualified faculty with innovative methods of teaching, who emphasize on different modes of learning for students as collaborative, peer, self, project based, research based, experiential in the form of internship etc. Further TCET has a well defined infrastructure and flexible curriculum with strong training and research activities and industry linkages under autonomy.

HSD has been incorporated in autonomous scheme in the form of Program specific curricula with focus on research in emerging areas of Engineering and Technology, non-credit mandatory courses, Internships and all round personality development model through HSD as per the AICTE model curriculum and UGC regulations since academic year 19-20. HSD is further carried out in form of Industry specific/Industry linked curricula through Employability Skill Development (ESD), Professional skills (PS), Project Based Learning (PBL) and Activity Based Learning (ABL) with co/extracurricular / extension activities and Research Based Learning (RBL). Autonomy scheme includes scholastic (academic), non-scholastic (personality development) and co scholastic (life skills, attitude and values) credits mandatory for all students. Further students shall be provided extra ordinary / achievers credits and credits for specialized and online courses under emerging areas. The model has been presented in Fig. 1. below:

Academic Scheme					
BS	ES	HSMC	Core	PE	OE
Non Credit MC					
Summer Internship					
Activity Points					
Holistic Students Development					
ESD	PS	PBL	ABL/RBL		
			Co	Extra	Extension

Fig 1. Current model under autonomy

New Education Policy (NEP) 2020 gives the institute further pointers. The model stated below lays emphasis on holistic education, wherein students pursuing various courses shall be provided internship opportunities taking the current model a step ahead in local business/ industry, artists, craft persons etc. Holistic education is a comprehensive approach to teaching where educators seek to address the emotional, social, ethical and academic needs of students in an integrated learning format. Students will also have an option to take up research internships with faculty and researchers of the respective HEI, which probably is being done informally currently. This activity will not only improve students' practical side of learning but also improve their employability. Internships and outhouse projects shall provide experiential learning. Experiential learning is learning through working in teams thereby enhancing communication skills and then reflecting on the handson experience gained. Currently multiple groups have worked on real life projects during hackathons, consultancy and grants. Even students undergoing PBL, ABL and RBL, even in social internships have experienced the same. Students in 21st century need multidisciplinary education along with research based specialization to facilitate high quality holistic education. Through multidisciplinary approach in education, one gets a holistic understanding of the world. Students are required to chose electives for credits. They learn more at once, develop critical thinking and problem solving skills, diversify their interests and opportunities and gain unique classroom experiences.

Further, Academic Bank of Credit (ABC) proposed by the University Grants Commission (UGC) will let students store credits earned from various recognized HEIs. Thus students can accumulate, transfer and redeem their credits. Availability of exit option post 1 year as certificate course or 2 year as diploma course or 3 year as degree course shall promote Multiple entry, Multiple exit and thus help students grow as per their interest. This shall allow students to leave and rejoin programme as per convenience. Students can leave a course and join back within a stipulated period without missing the credits earned during the missed duration, avoiding the fear of wasting years. Multiple entries and exit options, choice of electives, choice of duration and choice of earning credits from various HEIs will come to the students through ABC. Candidates who complete 4-year degree courses will also get 'Degree with Research' if he/ she completes rigorous research specified by the Higher Education institute. A degree with research will allow one to conduct his/her unique research and produce new knowledge and expertise that is innovative and relevant. This model has been proposed in Fig. 2. below:

Holistic Education
Multidisciplinary Education
Experiential Learning
Academic Bank of Credits
Multiple Exit options
Degree with research

Fig. 2. Proposed Model components as per NEP 2020

4. Experimentations

The First Year (F.E.) scheme offers courses on basic sciences (BS), engineering sciences (ES) alongwith Humanities, Social Science including Management courses (HSMC). It further offers professional skills (PS) and Activity Based Learning (ABL). Second Year (S.E.) scheme offers programme specific core subjects. Third Year (T.E.) scheme offers domain specific industry electives (PE) and Final Year (B.E.) scheme offers open electives (OE). Activity Based Learning (ABL) is carried forward in T.E. and B.E. as Research Based Learning (RBL). HSD offers courses on Professional skills (PS) including basic technology for S.E. and Industry/Research/Entrepreneurship for T.E. and B.E. Non credited Mandatory Courses (MC) are introduced as per AICTE model curriculum. Internships would enhance their skills as per industry needs. Activity Based Learning includes co-curricular/extracurricular/extension activities. Even the examination scheme includes formative and summative evaluation for continuous evaluation. Assessment of HSD activities being audited course is through presentation and report submitted end of semester. TCET is confident of deploying HSD activities since the

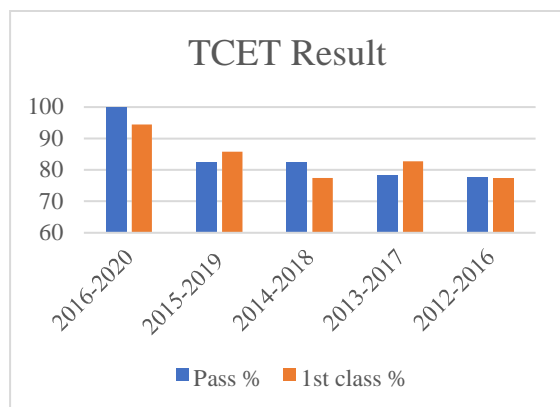academic results have shown improvement over the years as shown in Fig. 3. below:

Fig. 3. Academic Result (5 years)

TCET Training and Placement Cell conducts Preplacement Training and Talks (Aptitude Training and Test), Corporate Training (Ethics and etiquettes, resume building, GD and interviews), Infosys Campus Connect Programme (ICCFP 1.0 to 5.0), Student Development Programme (Soft skills and Technical), Inhouse and Outhouse Internships and Projects, Industry oriented Workshops in collaboration with Corporate Social Responsibility and Alumni Meet (Alumni contributing to T&P activities as well). Maximum salary package is around 21 lakh per annum with overall 118 companies visiting the campus. Many reputed companies as MuSigma, Infosys, Amazon, Accenture, TCS, JustDial, Seclore, Vistaar, Amdocs, Indian Navy, Zensar, L&T Infotech, Oracle, ByJUs, Cognizant and many more visit the campus.

TCET Higher education and Online Certification cell conducts orientation about competitive exams (GATE, GRE, TOEFL, IELTS, GAT/CET, A1/A2) for higher education in India and abroad, education fair, foreign delegates visit, collaboration with training institutes. Several online courses are offered through NPTEL and COURSERA platforms to students for self learning. Even workshops under IIT-B remote centre are conducted. The number of students opting for higher studies is seeing an increasing trend with 2321% increase since 2008 batch as demonstrated in graph below. Currently around 40% students show interest in higher studies.

TCET has been holding conference since 2010 in order to inculcate research culture in Higher and Technical institutions. In the initial 3 years, it was a single conference and thereafter we have been holding multiple conferences and workshops each year. The number of participants have increased each year. The affiliated journals being ACM, IJCA, IJACSA, IJAIS, Elsevier, IET, IRD, McGrawHill, IEEE, IJSER, i-manager, IARJSET, SCI Press, IOSR, apple press, Springer LNNS, etc. over the years.

5. Results and Discussion

To assess the acceptance of the model, survey was conducted on 136 students. The participants were second

year and third year students who have experienced 1 year and 2 year of autonomy at the department respectively. Following questions were asked:

Q1 Do you feel that internship included in autonomy scheme will help you groom professionally in terms of technical skills.

Q2 Do you feel that the curriculum designed under autonomy with Holistic student development will help you grab a high package job / admission into a renowned university.

Q3 Do you feel that the curriculum at TCET under autonomy is well structured and is competent to other private institutions.

Q4 Do you think that the institute has well laid out Teaching and Learning activities.

Q5 Do you feel that the initiatives under Activity/Research Based Learning shall make you globally employable.

Q6 Do you feel that promotion of self learning activities through specialisation courses under autonomy shall make you competent to graduates from renowned institutes.

Q7 Do you feel that activities under social internship and extension activities shall make you socially sensitive and ethically valued citizens.

Q8 Do you agree that the mandatory courses offered under autonomy are important for an individual's overall development.

Q9 Do you feel that the autonomous scheme is providing you enough avenues to select electives as per your choice.

Q10 Do you agree that the autonomy syllabus is grooming you well with respect to the exposure in terms of developing projects.

Fig. 4. below demonstrates the acceptance of current model, where majority acceptance can be seen for internships and self learning activities.
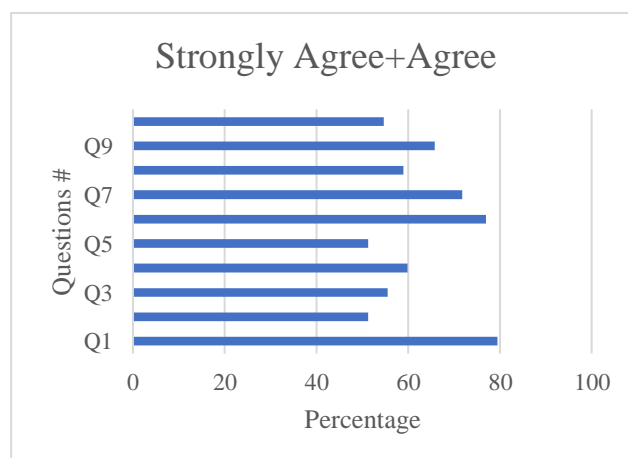

Fig. 4. Survey results demonstrating acceptance of current model

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To assess the credibility of model, survey was conducted on current final year students who have seen their next two batches undergoing the revised autonomy syllabus. Following questions were asked:

Q1. Do you feel internships should have been an important part of your curriculum

Q2. Do you feel Holistic Student Development activities (ABL, PBL, TBL, Bridge Courses) should be given credits in scheme

Q3 Do you feel the Mumbai University curriculum you underwent needed restructuring in terms of inclusion of non credit mandatory courses (Environmental Studies, Value Education, Indian Constitution and Essence of Indian Traditional Knowledge), credited internship, Holistic Student Development activities, extraordinary/achievers credits as specified in current autonomy scheme.

Q4 Do you think that the institute has well laid out Teaching and Learning activities (Theory, Tutorial, Practical, Formative/Summative Assessment, Oral/Practical, IAT and ESE)

Q5 Do you feel the activities under ABL conducted for your batch should be included in the scheme for credits

Q6 Do you feel self learning activities inculcate lifelong learning and TCET promotes the same

Q7 Do you feel students should be given elective choices early during their 4 year of engineering for interdisciplinary learning

Q8 Due you feel building projects helps you build your profile and hence should be part of curriculum

Graph in Fig. 5. below demonstrates the responses from 9 students where project based learning has received major acceptance in terms of need:
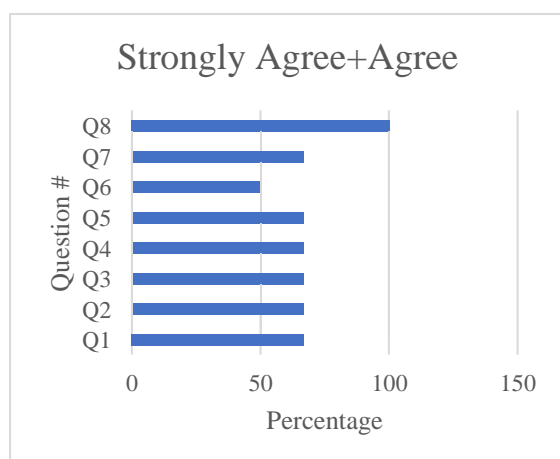

Fig. 5. Survey results demonstrating the need of current model

To assess the need of this revolution, survey questions were floated to the alumni who have experienced industry and higher education abroad:

Q1 Do you feel internships should have been an important part of your curriculum.

Q2 Do you feel HSD activities (ABL, PBL, TBL, Bridge Courses) undertaken for you by department should have been given credits in scheme.

Q3 Do you feel the Mumbai University curriculum you underwent needed restructuring in terms of inclusion of non credit mandatory courses (Environmental Studies, Value Education, Indian Constitution and Essence of Indian Traditional Knowledge), credited internship, Holistic Student Development activities, extraordinary/achievers credits as specified in autonomy scheme.

Q4 Do you think that the institute has well laid out Teaching and Learning activities (Theory, Tutorial, Practical, Formative/Summative Assessment, Oral/Practical, IAT and ESE).

Q5 Do you feel the activities under ABL conducted for your batch should be included in the scheme for credits.

Q6 Do you feel self learning activities inculcate lifelong learning and TCET promotes the same.

Q7 Do you feel students should be given elective choices early during their 4 year of engineering for interdisciplinary learning.

Q8 Due you feel building projects helps you build your profile and hence should be part of curriculum.

The results on 36 participants are stated in Fig. 6. below which demonstrates somewhat acceptance of the model particularly in terms of inclusion of internships, HSD, non credit mandatory course and project building:
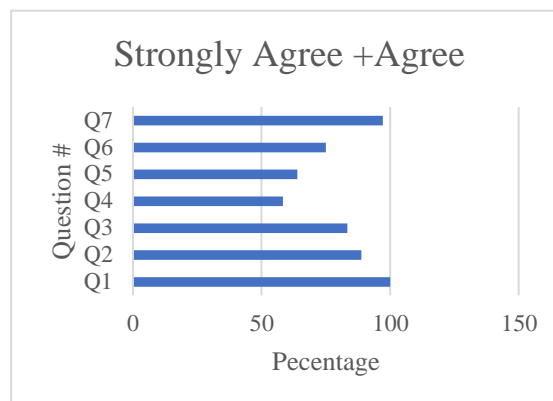

Fig. 6. Survey questions demonstrating the fulfilment of requirements of students of past batches

To assess the acceptability among TCET faculty, proposed model was floated to experienced academicians with following questionnaire:

Q1. The Academic Bank of Credit (ABC) proposed by the University Grants Commission (UGC) will let students store credits earned from various recognized HEIs so that the degrees from an HEI can be awarded taking into account credits earned and carry them forward in colleges

and universities. The ABC will function like a commercial bank where students can accumulate, transfer, redeem their credits. Do you approve of such a step.

Q2. Candidates who complete 4-year degree courses will also get 'Degree with Research' if he/ she completes rigorous research specified by the Higher Education institute. Do you approve of this idea.

Q3. As a part of holistic education, students pursuing various courses at HEIs will be provided internship opportunities in local business/ industry, artists, craft persons etc. Students will also have an option to take up research internships with faculty and researchers of the respective HEI. This activity will not only improve students' practical side of learning but also improve their employability. Do you approve of this thought process.

Q4. Availability of exit option post 1 year as certificate course or 2 year as diploma course or 3 year as degree course shall promote Multiple entry, Multiple exit and thus help students grow as per their interest.

Q5. The flexible and innovative curricula of Higher Education Institutes if incorporates –Credit-Based Courses, Projects in the Areas of Community Engagement & Service, Environmental Education and Value-Based Education shall make our graduates more globally acceptable

Q6 Multidisciplinary Education with arts and humanities and providing research based specialization will facilitate high quality holistic education

The results on 24 participants stated in Fig. 7. Below signify ready acceptance of Degree with Research component, internship opportunity, flexible curricula and multidisciplinary education. Academic Bank of credit and Multiple entry, Multiple exit options need to be introduced to the faculty in more explainable manner for acceptance:
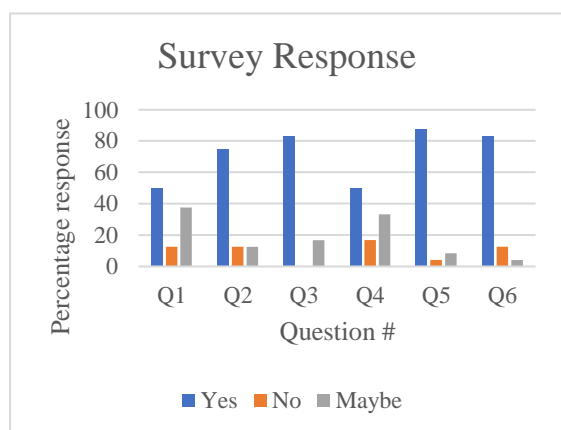

Fig. 7. Survey results demonstrating mixed response

6. Recommendations

Students were not readily accepting HSD activities at the onset of implementation since the activities were not credited in the curriculum and to execute the HSD activities, contact hours had increased. With time

motivation enhanced, since benefits of participation started coming as fruitful outcomes in the form of dream/ product company placements, admission in reputed institutions abroad etc. (Sedamkar, Gupta, Varoliya, Babbar, 2019) Students have exhibited certain characteristics/graduate attributes as being a responsible citizen, being able to manage time, being able to communicate (written and oral) effectively, being able to lead team and develop lifelong learning. The deployment was supported with strengthening from stakeholders.

Alumni survey received following suggestions as per Table I below out of which several pointers have been included in the current model already and others shall be included in the proposed model:

Table 1.

ALUMNI SUGGESTIONS PRESENT IN CURRENT MODEL

Sr. No.	Suggestion	Inclusion in model
1	Importance to group hands on assignments	Already incorporated particularly during online teaching and professional electives
2	Mandatory internship for which credits to be allocated	Already included in autonomy
3	Provide students with options to take subjects outside of the fixed curriculum as per their interest.	Incorporated in CBCGS-H under PEC and OEC
4	Introduce electives early in curriculum	Electives have been included right from Sem V under current model
5	Promotion of extracurricular or cocurricular activities	Inclusion of credits for the same under autonomy
6	Competitive Programming, best coding industry practices	Plan for coding club initiated
7	Usage and value of social media – LinkedIn, GlassDor, Quora, Reddit, etc. so that they socialize with seniors and gain from their experience.	Same has been incorporated under RBL with LinkedIn
8	Activities to bridge the gap between Senior and Junior batches in terms of grooming w.r.t academic and Extra-curricular goals.	Same has been included under Alumni Connect Programme
9	Inclusion of latest industry trends	Professional skill course content under autonomy can be revised as per industry needs for successive batches

10	Academic Research	Research Based Learning is included in current model for last 2 years
11	Collaboration with foreign universities for student exchange programmes	Same has been initiated as per AICTE policy
12	Industry relevant Domain workshops	Conducted under peer learning in each domain under PSR activity
13	Project per semester end	Same has been included in form of mini, minor and major projects

Multiple Exit options introduced in NEP 2020 was something very new. To understand how this would be taken in the stakeholders particularly those who may have felt the need of such a system, a survey was floated with following questions:

Q1. Due you feel that a student when enters into a course for a span of 3-4 years, should be given a chance to exit as per his interest developed during the course of study. The exit options being: post 1 year a certificate course. post 2 year a diploma course. post 3 year a degree course and thus help students grow as per their interest.

Q2. At any point of time during your graduation course did you feel the need to take a break or quit the course.

The results demonstrate around 88.9% participants agree and strongly agree of such an initiative. Around 22% feel that they felt the pressure of continuing the degree at some point during the course. Even my personal experience says that a span of 4 years is huge to bind a students to a course wherein at the entry point he is not sure of his preferences and interests because he is not much aware of the content that he will be undergoing. Moreover I have come across students who had great opportunities as internships, projects, research etc. which required them a full time attention and they could not grab such opportunities due to fixed curriculum and time span.

6. Conclusion and Future Scope

The CBCGS-H model proposed in this paper has shown immense positive response in takers and the previous batches also have appreciated the shift. This has given us confidence to propose the new model as per NEP pointers. Any new idea that is floated faces reactions in the beginning but if clarity and vision is there in the leadership then slowly acceptance is guaranteed. Moreover, multiple exit option can pose a concern for institutions in terms of revenue. Even the stakeholders had shown dissent at the initial stages of the current model that is well deployed and accepted now.

The model proposed above has shown immense positive response in takers and the previous batches also have appreciated the shift. Thus we propose holistic education from our experience. We also recommend multidisciplinary education as most of the projects and industries require multidisciplinary knowledge in order to propose solution to real life problems. We all have experienced that graduates who have gained experiential learning through projects and internships are more globally acceptable into product companies and start ups.

Further Academic Bank of Credits, Multiple entry multiple exit options and a degree with research need proper planning for acceptance among the stakeholders i.e. faculty, students and parents as well. Institutions need to brain storm as to how the monitoring of these shall be done in a errorless manner.

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