

Three-pronged (3P) Approach to Strengthen Feedback Mechanism in Engineering Education

Meenu Khurana, Manoj Manuja

Chitkara University Institute of Engineering and Technology
Chitkara University, Punjab, India

Abstract: Effectiveness in teaching-learning process and attainment of program outcomes are the areas for which educational institutes are largely accountable. Internal feedback mechanism is the key to enhance the quality of teaching-learning process thereby contributing towards attainment of program outcomes and hence important for the growth of institute. This mechanism should be strong enough for receiving adequate information from stakeholders to help in tweaking or improving the processes. Feedback from students has been a common mechanism being followed in the educational institutes. Also, the industry feedback is considered for curriculum revision. In this paper we will discuss about three-pronged (3P) approach for such a feedback mechanism. Three prongs in this approach are the closed loop feedback mechanism, sensitizing students about the importance of feedback and agility in feedback process. Designing feedback and analyzing the feedback received from all the sources in tandem is the backbone of this approach and has been discussed in detail in this paper. The paper presents case study of implementation of proposed 3P approach to enhance the students' learning of computer programming course.

Keywords: feedback, teaching-learning process, feedback design, feedback analysis, agility

1. Introduction :

With the growing awareness among engineering education institutes about the need to focus and improve the students' preparedness for the demanding environment, the Teaching-Learning Process (TLP) has gained great attention of the education fraternity. There has been a shift in the teaching-learning process due to great usage of instructional technology, professionalism of teaching fraternity and greater accountability of educational institutes. Due to recent impact of pandemic the 'online' teaching-learning became the de-facto method. Irrespective of the pedagogical changes in TLP, feedback mechanism remains the powerful way to evaluate the efficacy of TLP and therefore must be robust to evaluate the effectivity with each of the iterative changes (Miriam Bar-Yam, et.al., 2002), (Niva Wengrowicz, 2014), (Yong Zhao, Jim Watterston, 2021), (Temitayo Deborah Oyedotun, 2020).

At this point it is important to introspect the existing feedback mechanisms for its effectivity in improving quality of engineering education. Students' feedback alone cannot help in improving quality in the process (Bianka Malecka, David Boud & David Carless, 2020). Researchers have suggested two-way feedback mechanism (V.G. Renumol, et.al., 2017) with only students and teachers as stakeholders.

Meenu Khurana, Manoj Manuja

Chitkara University Institute of Engineering and Technology,
Punjab, India.
meenu.khurana@chitkara.edu.in

Moreover, the generic parameters considered cannot be made applicable for any specific process. Feedback must be an exhaustive process of designing and analyzing iteratively to produce the desired outcome.

The major stakeholders for taking feedback are teachers, students, alumni and industry. Feedback by teachers to students about their work and by students about teaching are important in structuring the learner centric TLP.

This study focuses on three-pronged (3P) approach for feedback mechanism that consists of (i) closed loop feedback mechanism comprising of iterative process of identifying the problem area, designing feedback questionnaire in cohesive manner for stakeholders, (ii) sensitizing students about the importance of feedback and guiding them on how to give open ended feedback comments, (iii) agility in feedback designing by getting inputs from stakeholders while designing the feedback questionnaire. The 3P approach has been suggested as major step towards improvement in the feedback mechanism. Here, the strategy to analyze feedback collated from the three stakeholders is important to get the desired action points useful for improving TLP.

The paper has been organized as follows: Section II discusses the existing feedback mechanism. Section III covers the proposed 3P approach focusing on each of the vital element of the feedback mechanism. Section IV focuses on the methodology for implementing 3P approach followed by result analysis and discussion based on the case study in section V and conclusion in section VI.

2. Feedback Mechanism

Constructive feedback is the key to quality enhancement of the teaching-learning process. Students' feedback is a powerful tool to know about the effectiveness of the teaching practice adopted by teachers (Luke Mandouit, 2018), (Holger Gaertner, 2014). It is a valuable source of information for improvements in instructional effectiveness but can never be an elixir for the ailments. There is enough empirical evidence to indicate that student feedbacks provide reliable and valid information, but can be biased under the influence of many other factors, and hence cannot be the panacea for providing solution for the best teaching-learning strategy (Svinicki, Marilla, 2001). Student feedback on teaching falls far short of a complete assessment of a teacher's teaching

contribution. The informal feedback discussed in literature has its own barriers (Alexandra Meikleham, Ron Hugo, 2017). The formal feedback or hybrid feedback designed for students must be an iterative process, else will not be helpful (Chenicheri Sid Nair, Arun Patil, Patricie Mertova, 2011), (Renée E. Stalmeijer et.al, 2022). The feedback spiral approach discussed in literature for teachers' feedback on students' assessment is only one way of feedback (David Carless, 2019). The approach can be implemented for the feedback from other stakeholders as well.

The feedback from alumni and industry is important which is generally part of feedback process (Irene Garcia, Richard W. James, Paul Bischof, Anne Baroffio, 2017), (Meenakshi Sankaran, Amiya Kumar Rath 2021). The analysis of feedback of various stakeholders can give a fair idea of improvement but will not reveal the facts and thus may not lead to correct action points for improvement/s required, if any. The proposed 3P approach provides a robust mechanism for feedback process.

3. Three- Pronged (3P) Approach

3P approach focuses on the three important prongs of the feedback mechanism.

(i) First prong which is at the core of this approach is the closed loop feedback mechanism depicted in figure 1.

The purpose of feedback should be specific and not generic. Saying 'the feedback is for improving the quality of engineering education' is generic whereas the statement that 'the feedback is for enhancing the students' learning in programming course in computer science' is more specific in nature. Parameters for the identified process should be measurable to help in designing action points. Stakeholders for collecting feedback are to be identified based on the decided parameters and the feedback questionnaire to be designed accordingly.

Based on analysis of the feedback, the action points are to be formulated and accordingly action to be taken. In closed loop, quantifying the improvements in process are a must to check for success of the feedback mechanism. If requisite amount of improvement has been noticed, the feedback loop can be exited, or else, the loop will continue till requisite improvement is achieved.

(ii) Second prong in this approach is sensitizing students about importance of feedback and guiding them to give meaningful feedback. To draw the valuable information about TLP, students' feedback is important. It has been discussed in the previous section that students are unaware about the importance of their feedback and sometimes are unable to express themselves or phrase their inputs in appropriate words for the comments (Marilla Svinicki, 2001), (Bianka Malecka, David Boud & David Carless, 2020).

Specific sessions for students about the feedback process and training them to put forward their point by giving open ended comments will be helpful in getting the meaningful feedback. The session can be included as part of mentoring sessions for the students. Without sensitization and training, we cannot expect that the feedback will be helpful in drawing relevant conclusion leading to specific action points for improvements.

(iii) Third prong in 3P approach is the agility in the feedback process. The generic feedback questionnaire, though important, cannot be helpful in improving a specific process. For the purpose, process specific feedback questionnaire needs to be designed. Agility in feedback designing can be resulted by replacement of standardized feedback process with flexible one, process focused and consisting of iterative loops. Further for better results, the identified process requiring improvement through feedback can be diverged into sub-processes and each one of it can be considered separately.

4. Methodology

The three prongs of the 3P approach of feedback mechanism have been discussed in the previous section. At the core of the proposed approach is first prong i.e., closed loop feedback mechanism, having the following steps as depicted in fig. 1:

Step 1: Clearly defining the purpose and identifying the process for improvement through feedback. Defining measurable parameters for evaluating the process.

Step 2: Identifying the stakeholders for taking feedback based on the decided parameters and designing feedback questionnaire in cohesive manner.

Step 3: Analyzing feedback in tandem as received

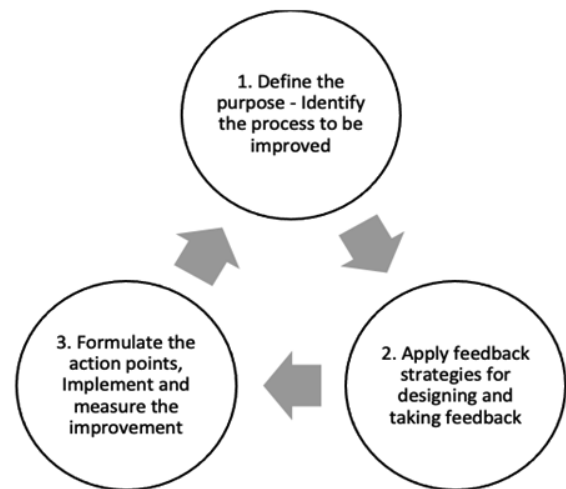


Fig 1: Three-pronged approach for feedback

from the stakeholders by assigning the weightage factors to the responses, calculating the improvement based on the defined threshold value and formulating the action points based on the analysis.

As this approach is a closed loop mechanism so the action points will help in identifying the process for the next iteration of this loop. Further this process will continue for number of iterations till the required threshold value is achieved.

While designing the feedback questionnaire for the case study presented in next section the agile methodology was followed and before sharing the feedback with the students, sensitization session was conducted. Students were mentored for providing open ended comments in the feedback.

6. Results And Discussion

This section represents the case study for the proposed 3P approach implemented in the organization. While designing questionnaire the framework of standard feedback questionnaire was picked and iterative changes were made specific to the process. One hour session for students were conducted about the importance of feedback and inputs were given on how to use the words effectively to phrase the feedback comments.

The steps below present the closed loop feedback mechanism.

Step 1: For our case study, the process – “Enhancing students' skills in computer programming”, was

considered. The three major measurable parameters for the process were identified as students' performance in the assessments, industry relevance of course curriculum judged through the industry hiring and effectiveness of teaching learning methodology.

Step 2: In our study, we earmarked three stakeholders based on the identified parameters, who could provide the honest feedback. Current students and alumni, faculty members having expertise in the area and employers were identified as stakeholders.

A standalone feedback questionnaire designed for an individual stakeholder cannot result in the valid analysis and will be of no significance in deciding action points for improvement. In our feedback, we designed correlated questionnaire related to the three parameters considered in previous step. The cohesiveness in the questions designed for the respective stakeholders is the key behind the 3P approach. Table I represents the subset of questionnaire designed for the first stakeholder i.e., students and alumni on the three defined parameters. Table II collates the subset of the questions designed

Table 1 : Feedback Questionnaire For Students And Alumni

S. No.	Questions on Curriculum
CS1	How did you find the course curriculum?
CS2	Were the reading materials and references regarding course easily found?
CS3	Was the course relevant to your job or to your future aspirations?
CS4	Was the course applicable in your practical / daily life?
	Questions on Teaching -Learning methodology
TLS1	Did the course provide enough hands-on exposure to you?
TLS2	Were there enough activities included in teaching the course?
TLS3	Were there any Industry interventions during teaching of the course?
TLS4	Were there enough challenges given during class to make it more interesting?
	Questions on performance in assessments
AS1	How helpful was the feedback you received about your assessments?
AS2	Could you suggest and provide solution for the real time problems through your knowledge about the course?
AS3	Were the difficulty level of assignments high as compared to the problems covered during class?
AS4	Were the reading material and references provided enough to complete the assignments?

for the second stakeholder i.e., faculty members and table III represent the subset of the questions designed for the third stakeholder i.e., Industry or Employer.

Table 2 : Feedback Questions For Faculty Members

S. No.	Questions on Curriculum
CF1	Did the Board of Studies take care to ensure the concurrency and relevance of the course offering?
CF2	Were you given enough freedom to contribute your ideas on curriculum design and development?
CF3	Was Employability given weightage in curriculum design and development?
CF4	Was representation from business and industry in Boards of Studies helpful in designing and improving the courses?
	Questions on Teaching -Learning methodology
TLF1	Are teaching aids in the department sufficient and up to date?
TLF2	Are the faculty members being provided adequate learning resources?
TLF3	Are the faculty members updating their knowledge and skills?
TLF4	Are the faculty members encouraged to establish linkage with industry or other institutions?
	Questions on performance in assessments
AF1	Did the feedback on assessments helped students in enhancing their learning?
AF2	Were the minimum required course outcomes attained?
AF3	Is the evaluation system being followed effective?
AF4	Are there enough resources to assess students on practical aspects of the course?

Table 3:Feedback Questions For Industry or Employer

S. No.	Questions on Curriculum
CE1	Is the learning in terms of skills, concepts, knowledge, analytical abilities and broadening perspectives, worth enough for industry?
CE2	Is the course applicable or relevant to real life situations?
CE3	Is the scope of the course as per the need of industry?
CE4	Is the depth of course content worth enough?
	Questions on methodology of Teaching -Learning
TLE1	Is extent of effort by students good enough?
TLE2	Does the projects done by students reflect the true problem - based learning approach?
TLE3	Are the students encouraged to contribute in the global community of programmers?
TLE4	Are the students able to align themselves to the needs of the industry?
	Questions on performance in assessments
AE1	Does grades of the students truly reflect the level of knowledge?
AE2	Are the students able to showcase reasonably good professional capabilities?
AE3	Have the students acquired problem solving skills?
AE4	Does solutions provided by the students focus on optimization of complexity and efficiency?

The related feedback questions on curriculum from all the three stakeholders were mapped to the maximum possible extent.

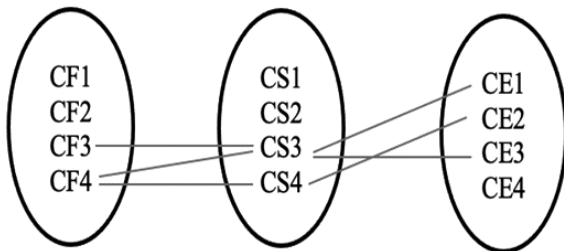


Fig. 2: Mapping of questions from three stakeholders for curriculum parameter

Few such sample mapping of questions on curriculum is represented in fig. 2, referring to the questions numbered in table 1, table 2 and table 3.

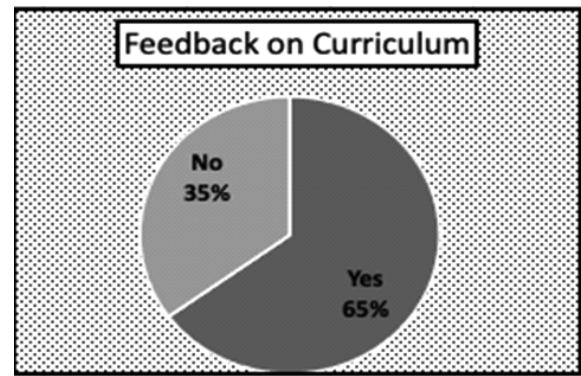
To get the good response, it is important that questions should be more objective in nature than being subjective. The binary answers or four-point Likert scale options for these questions were considered for analysis.

Along with the designed questionnaire, other subjective questions if answered appropriately can help in firming the opinion, like - the most useful part of the course curriculum and why; the least useful part of the course curriculum and why; any other changes would you like to suggest for improving the course curriculum; the challenges faced by you in studying the course etc. At the same time subjective questions will make the questionnaire lengthy thereby resulting in low response ratio. For our study we added an open-ended comments field in the feedback.

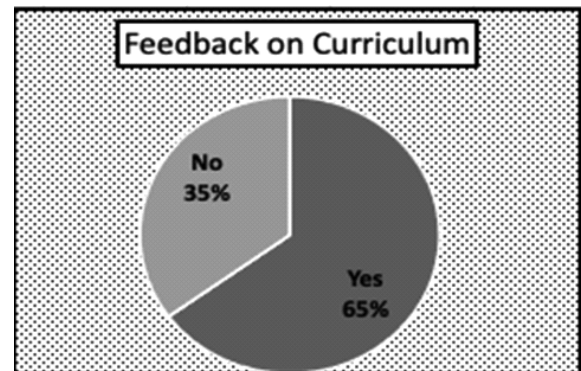
These questions can be rephrased depending on the requirement. While designing a feedback questionnaire it is must to focus on these major points, ask only the most relevant questions and directly related to the purpose. Lengthier the feedback, lower will be the response rate.

Step 3: The feedback on the three parameters was obtained from the stakeholders and results were analyzed. Fig. 3 represents the feedback response on curriculum from the three stakeholders.

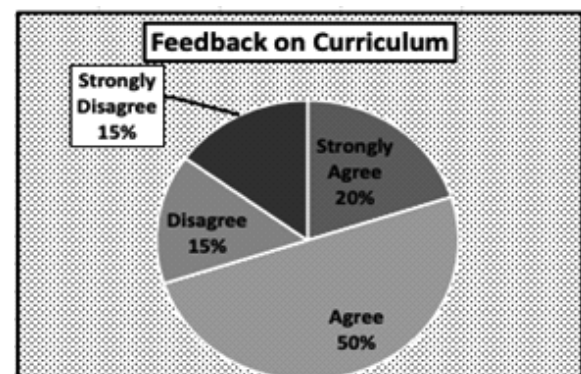
The feedback received from 200 students, 50 alumni, 50 faculty members and 30 employers were analyzed. Fig. 4 depicts the feedback on teaching-learning methodology and Fig. 5 represents the feedback on assessments.



a)

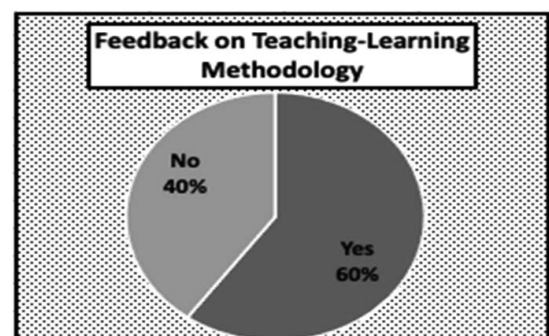


b)

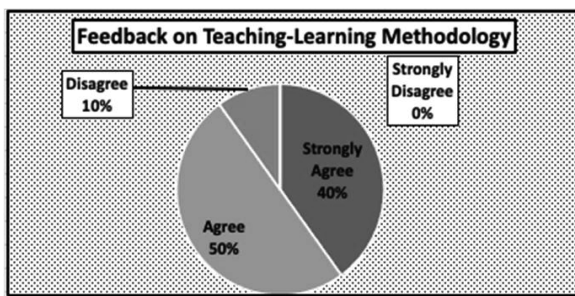


c)

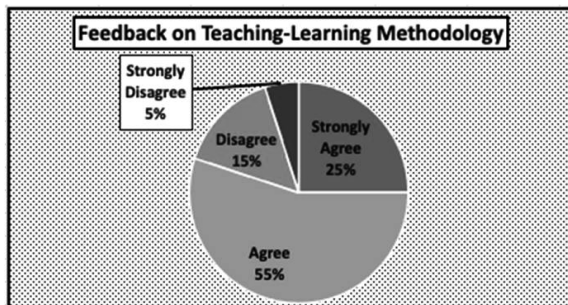
Fig. 3: Feedback on curriculum
a) by students & alumni b) by faculty c) by employers



a)

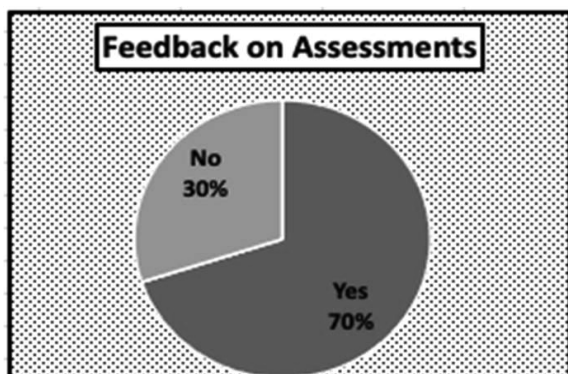


b)

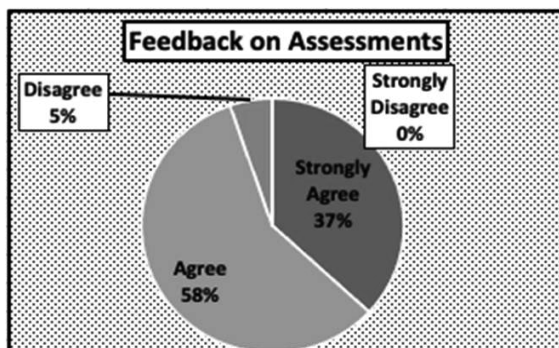


c)

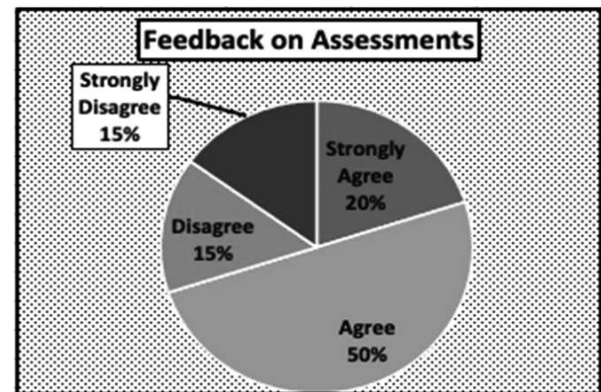
Fig. 4: Feedback on teaching-learning methodology
a) by students & alumni b) by faculty c) by employers



a)



b)



c)

Fig. 5: Feedback on assessments
a) by students & alumni b) by faculty c) by employers

Referring to fig. 4, feedback on teaching-learning methodology has positive response from 60% of students, 90% of faculty and 80% of employers and as per fig. 5, 70% of students, 95% of faculty and 70% of employers have given positive feedback.

From the analysis is it evident that no action is required for the improvement on any of the three parameters as all the values are above threshold of 50%. For this approach the weightage has been assigned to the responses of the stakeholders and final weightage is calculated based on which action is taken.

The table 4 below shows the weightage values ranging from -1 to 1 of the responses assigned in the proposed 3P approach. The weightage was decided based on the course objectives, course outcomes and mapping of course outcomes with program outcomes.

Table 4 : Weightage Values of Feedback Responses

Response	Weightage
Yes	1
No	0
Strongly Agree	1
Agree	0.8
Disagree	-0.8
Strongly Disagree	-1

The related feedback questions on curriculum from all the three stakeholders were mapped to the maximum extent possible as shown in fig. 2 and cumulative weight factor was taken that came out to be 0.48 indicating that more than half of the stakeholders are not positive about this. Similarly, the calculations of feedback for other two parameters give the weight factor of 0.61 and 0.59 respectively. The threshold value of 0.5 for these parameters was considered as acceptable, leading to no action required for the two parameters but only for curriculum.

Any value less than threshold needs action, so action points were decided, the course curriculum was designed to be focused as per industry requirement. The changes were suggested in board of studies and approved. The same feedback questionnaire after the offering of the programming course resulted in weight factor of these related questions as 0.62 which was higher than the threshold of 0.5 for the cumulative weight factor.

With the feedback mechanism through 3P approach, the three prongs acted together and helped in critically analysing the root cause of the issue and curating action points. The performance of the approach was validated through the improvement in students' skills as measured by their academic performance and placements as compared to previous years. Further the teaching methodology was improved based on the feedback.

At the core of 3P approach is the strategy for analyzing the feedback. In our case study 0.5 weight factor is the threshold and for further improvement the threshold can be enhanced to a higher level and the same approach can be followed for measuring and improving.

For more precision in assigning weights, assessing, and analyzing the feedback, RASCH model can be applied (Rikkert M. van der Lans, Wim J. C. M. van de Grift, K. van Veen, 2018). This will lead to another important area of research in the proposed feedback approach.

6. Conclusion

A strong feedback is very crucial for attaining improvement in the quality of higher education. Standalone feedbacks from any of the stakeholders cannot help in deciding the action points for

improvement. 3P approach proposed in the paper focused on three prongs of closed loop feedback mechanism, sensitizing students about feedback and agility in feedback. Further the core of proposed approach is closed loop feedback consisting of three steps, i.e., defining the process, applying feedback strategies and formulation of action points in cyclic manner till the desired outcome is achieved. Feedback strategy has been further divided into two tasks, designing cohesive questionnaire for the stakeholders, and analyzing feedback by the weight factor. These processes will help in quantifying the analysis which will further help in designing and implementing action points for the quality improvement. The weight factors and the threshold weight values are important in this mechanism which may be decided by critically analyzing the course objectives, program outcomes and program educational objectives, status of the process and by quantifying the anticipated improvement in first iteration of the feedback mechanism of 3P approach. To get more precision in the feedback analysis for the proposed 3P approach, RASCH technique can be explored in future.

References

- [1] Miriam Bar-Yam, Kathleen Rhoades, Linda Booth Sweeney, Jim Kaput, and Yaneer Bar-Yam (2002). *Complex Systems Perspectives on Education and the Education System*. New England Complex Systems Institute.
- [2] Niva Wengrowicz (2014). Teachers' pedagogical change mechanism – Pattern of structural relations between teachers' pedagogical characteristics and teachers' perceptions of transactional distance (TTD) in different teaching environments”, *Computers & Education*, Vol 76. pp 190-198.
- [3] Yong Zhao and Jim Watterston (2021). The changes we need: Education post COVID-19. *Journal of Educational Change*, Vol 22, pp 3-12.
- [4] Temitayo Deborah Oyedotun 2020. Sudden change of pedagogy in education driven by COVID-19: Perspectives and evaluation from a developing country. *Research in Globalization*, Vol 2.
- [5] Bianka Malecka, David Boud & David Carless (2020). Eliciting, processing and enacting

- feedback: mechanisms for embedding student feedback literacy within the curriculum, *Teaching in Higher Education*, DOI: 10.1080/13562517.2020.1754784
- [6] V.G. Renumol, G. Krishna Kumar, G. Gopeekrishnan and Nisha S. Raj (2017). Effective Teaching Learning Environment through Constructive Feedback: A Preliminary Study. *Journal of Engineering Education Transformations*, Vol 30, Iss 3, pp 200-205.
- [7] Luke Mandouit (2018). Using student feedback to improve teaching. *Educational Action Research*, Vol 26, Iss 5, pp 755-769.
- [8] Holger Gaertner (2014). Effects of student feedback as a method of self-evaluating the quality of teaching”, *Studies in Educational Evaluation*, Vol 42, pp 91-99.
- [9] Alexandra Meikleham and Ron Hugo (2017). Understanding informal feedback to improve online course design. *European Journal of Engineering Education*, Vol 45, Iss 1, pp 4-21.
- [10] Chenicheri Sid Nair, Arun Patil and Patricie Mertova (2011). Enhancing the quality of engineering education by utilising student feedback. *European Journal of Engineering Education*. Vol 36, Iss 1, pp 3-12.
- [11] David Carless (2019). Feedback loops and the long-term: towards feedback spirals. *Assessment & Evaluation in Higher Education*. Vol 44, Iss 5, pp 705-714.
- [12] Irene Garcia, Richard W. James, Paul Bischof and Anne Baroffio (2017). Self-Observation and Peer Feedback as a Faculty Development Approach for Problem-Based Learning Tutors: A Program Evaluation. *Teaching and Learning in Medicine*, Vol 29, Iss 3, pp 313-325.
- [13] Meenakshi Sankaran and Amiya Kumar Rath (2021). Assessing Undergraduate Engineering Programmes using Alumni Feedback. *Journal of Engineering Education Transformations*, Vol 34, 2021, Special issue, pp 733-741.
- [14] Renée E. Stalmeijer et. Al. (2022). Continuous enhancement of educational quality – fostering a quality culture. AMEE Guide No. 147, *Medical Teacher*, pp 1 - 11 , 10.1080/0142159X.2022.2057285
- [15] Marilla Svinicki, (2001). Encouraging Your Students to Give Feedback. *New Directions for Teaching and Learning*. Wiley Publishers. Pp 17 -24. 10.1002/tl.24.
- [16] Rikkert M. van der Lans, Wim J. C. M. van de Grift & K. van Veen (2018). Developing an Instrument for Teacher Feedback: Using the Rasch Model to Explore Teachers' Development of Effective Teaching Strategies and Behaviors, *The Journal of Experimental Education*, 86:2, pp 247-264, DOI: 10.1080/00220973.2016.1268086