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Online assignment approach in mechatronics system design course using Google classroom

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Abstract : In this cyber-driven world, assignments are submitted by higher education students by using pen, paper and pencil. With the outbreak COVID-19, the smart phones, tablets and computers/laptops play a vital role in educating the school students as well as higher education students. Despite the fact that the current generation students' skill development is through additional education modes like assignments, formative assessment, and model-based assignments and so on, the teaching and learning process remains old. Very few educators are using smart education tools to collect feedbacks, to assess student's knowledge using open CV's like Padlet, Plickers, Moodle and Google classroom. The introduction of online assignment submission enriches the student's skills, knowledge and content development skills. In this paper, the student's activities for submission of assignment and subject content clarification are performed using Google classroom as an interactive tool. The introduction of online assignment submission creates measurable difference in student's performance over traditional assignment submission. Although the student's performance, student characteristics and study behavior are explained using case study on Mechatronics system Design course and its impact on the students for further improvement in education system.

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1. Introduction

The online learning system has made student's education more malleable and customizable based on their necessities. The development of student education through learning by practice, Hands-on experiments, proper usage of course materials, referring books and sharing knowledge. Whereas, the current education system has certain measures to identify the student's incapability over the courses by assessing students through insufficient assignments, and unrelated formative assessment methods. The student's measure is important in current scenario, whereas the initialization of technology-based measures afford student learning activity to next level from CBCS to CDIO taxonomy.

Doorn et.al explained that online assignments increase the student motivation and research idea towards the course and encourage the students to do further research in the current applications [1]. Grieve et.al affirmed that enhancement of internets and computer usage among students extends the altitude to augment knowledge on perception towards social presence. The difference in online and offline mode submission has its own positive and negative feedbacks among the students in higher education [2]. A. M. Quteishat, et.al interpreted about traditional assignments submission system, the student should surrender a hard copy of the assignment at stipulated time duration at faculty cabin. This process is more time consuming and effort wastage over activity. The

educator also spends more time to validate the submitted assignment [3]. D. M. Slattery and Y. Cleary recommended that online collaborative learning facilities reduce the potential isolation that create often in off-line education. The online assessment encourages the student motivation and facilitates the deep learning concept over each course [4]. X. Su et.al projected that the introduction of NPTEL, MOOC courses paced their own timetable and delivered the content in more collaborative manner and introduced the assessment based on online submission. These approaches lessen time consumption for avoiding error in the assessment strategy [5]. McCord elucidated about the major disadvantage in online assignment is plagiarism. To overcome the copying of others content in their booklet in traditional system can be reduced in online assignment system. Though there are advantages, plagiarism was increased in online assignment than traditional system [6]. Michael Batu, et.al illustrated that online assignment has made students to perform better in summative assessment at end of the course [7]. Osman GaziYildirim et.al, suggested that the online assignments encouraged students to evolve as follows [8],

- To analyze the student's perspectives in learning approach through introduction of online assignment over traditional approach.
- To predict the problems faced by students while submitting their assignments and provide solutions
- To identify why most of the students, fail to submit their assignments on time.
- To identify the difficulties faced by the educators while measuring assignments.
- To analyze an alternate solution for current problem in submitting hard copy assignments.

From the above literature, engineering students' skills are developed through implementation of pioneer teaching approaches and online assignments with hands on. This study further elaborates the difficulties in implementing the ICT tools among engineering courses. In this paper, Chapter I deals about the introduction and literature survey. Chapter II demonstrates the types of assignments and activities used to engage the students during in-class session.Chapter III provides the case study about the students' activities in learning the Mechatronics system design course. Chapter IV delivers the advantages of using Google classroom applications. Chapter V explains results and discussion of student's skills and grades based on online assignment. Chapter VI gives the conclusion and future work to engage the students in different case studies.

2. Learning Strategy For Engineering Students

Currently, the lecturing methods are broadly classified as online based lecturing and offline based lecturing methods. The classification of offline lecturing techniques is conventional and Active learning methods. In conventional method, instructor prepares lecture material and dictating to the students using black board or PPT. In Active learning method, instructor creates an ecosystem among students to create more interaction than lecturing session. Currently, the lockdown due to pandemic, online lecturing mode is widely followed in schools and colleges. The selection of assignments will be different in the innovative classroom where the usual classrooms follow the conventional assignments which are listed below,

Conventional assignments:

- Written assignments
- Problem solving as Homework.

Innovative assignments:

- Flipped classroom-based assignments
- Demonstration
- Activity based assignment.
- Peer Activity.

3. Online Assignment

The researcher has chosen the third-year students of Mechatronics in Thiagarajar College of engineering as the samples. The mechatronics system design course is taught to the samples in order to enrich the essence of basic concepts studied earlier, which are integrated and developed to innovate a product at low cost which are highly effective for the society. The introduction of such courses helped students to emerge as an entrepreneur. The course outcomes and assessment patterns are as follows,

This course highly focuses on product development-based learning approach in CDIO education pattern. In this format the assignment delivered by the students must be productive and useful for the development of product. Thus, the assignment for this course was converted into online assignment where the submission and validation or assessment is done through Google classroom platform. The Google classroom is a free web service developed mainly for school and college students. With the help of this application in mobiles, the learners and teachers are able to chat, communicate, create group, submit activities, submit the assignments and validate the assignment in Google classroom.

In this paper, the detailed study of online assignment which address Course outcome 2 and 4 (as shown in table 1) and its assessment methods. Likewise, the course outcome 4 assessments had been done with advisor made rubrics pattern.

Table 1. Course Outcome for DC Machine

CO 1	To explain the components required for design Mechatronics system	Understand
CO 2	Design Bond graph model for mechanical, Electrical and Hydraulic system	Apply
CO 3	Select the sensor and Actuator for a various Mechatronic application	Apply
CO 4	Develop a Mechatronic product for given Industrial problems	Apply

The course outcome 2 was submitted through online platform using Google classroom. The submitted assignment had been validated and marks were allotted in Google classroom itself. The development of dynamic environment among students in both online and offline platform through introduction of flipped classroom [10]. The peer learning and classroom teaching along with flipped classroom activity was delivered to third year Mechatronics students (70 no's). As the strength of classroom was high, the activity was planned as group-based activity. The lectures were delivered based on the lecture plan and the assignment 1 was fully based on chapter 2.

The chapter 2 dealt with modeling of mechatronics system using design and simulated platform like Bond graph and solid works. Since the design using bond graph was easy to understand for the weak students, the mechatronics system was designed using bond graph for various system like Electrical, Mechanical and Hydraulic. The chapter 2 syllabus lecture pattern and flow diagram are shown below.

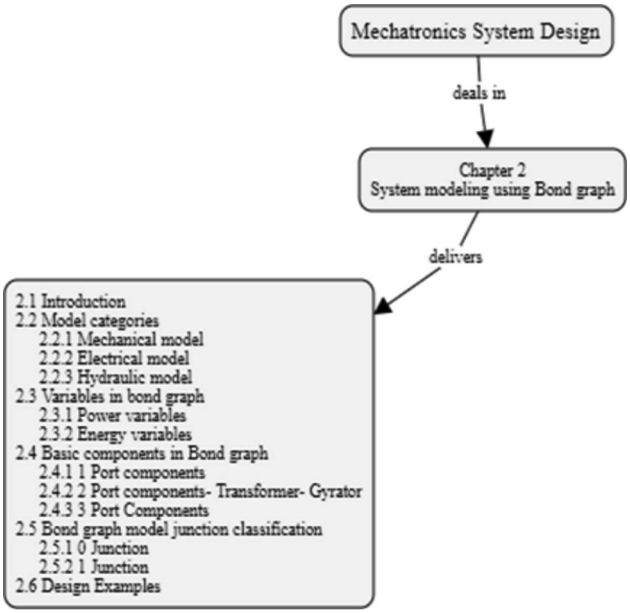

Fig. 1: Concept map for Chapter 2 in mechatronics system design

The chapter 2 dealt with modeling of mechatronics system using design and simulated platform like Bond graph and solid works. Since the design using bond graph was easy to understand for the weak students, the mechatronics system was designed using bond graph for various system like Electrical, Mechanical and Hydraulic. The chapter 2 syllabus lecture pattern and flow diagram are shown below.

Table 2 : Chapter 2 syllabus hour allocation

2	System Modeling by Bond Graphs	Hour
2.1	Introduction-model categories-fields of application	1
2.2	Variables in bond graph- Power variables – Energy variables	1
2.3	Basic components in Bond graph-1 Port components	1
2.4	2 Port components- Transformer- Gyrator	1
2.5	3 Port Components – 0 Junction, 1 Junction	1
2.6	Design Examples	3

4. Case Study Scenario

In figure 2, the online assignment-based learning in Mechatronics system design course is explained. Comparing the conventional and active learning technique which provides detailed explanation of student centric learning process. In the proposed case study, the implementation of online assignment platform and the benefits of 14MT620 Mechatronics system design course is explained. The project-based learning activity is focused on the improvement of skills and engagement towards the course. In this

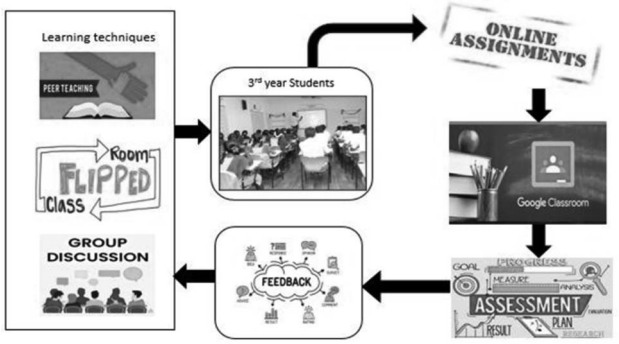

Fig.2 :Flow diagram for Online assignment-based learning.

course, chapter 2, modeling of system is done using bond graph which is selected as case study topic.

Chapter 2 reveals the following list of challenges to solve real time industrial problems.

1. Challenges in designing Mechatronics system

2. Challenges in optimizing real time mechatronics system

3. Challenges in analyzing mathematical model with practical varying parameters.

4. Challenges in simulating the model and implementing for real time mechatronics model.

A. Designing Mechatronics System Using Bond Graph:

The lecture delivered by the instructor comprises of definition of bond graph and explanations about the model developed using 20sim software and the control features analyzed in individual section of mechatronics system. Water bottle filling industry setup was considered, which was fully automated and consisted of motor for conveyor control, water level identified by sensors, water opening and closing using solenoid operated pneumatic or hydraulic valves. In this automation application, it comprises of electrical system (actuator, sensors), mechanical system (conveyors), and hydraulic systems (valves). Thus, the combination of all three elements develops a low cost and high-efficient mechatronics system. Therefore, the importance of all three systems and their bond graph component should be lectured unmistakably. To do this the instructor practiced the active learning techniques like flipped classroom, peer learning and group discussion. Since the topic is too technical, many weak students could feel complex to understand, so the peer

teaching technique plays a vital role to sort many doubts and problem raised by the weak students. The peer teaching defined in this course is the teacher or instructor identified few volunteers from final year BE class and few students from ME class and created a team to separate the third-year students into few groups and lectured them with latest ICT tools. This session also had the lectures of IIT professors from NPTEL platform. Later the instructor assigned videos from IIT professors' lecture and asked students to go through them as homework. In next class, each group of students along with peer volunteers were assigned problems based on the lecture video given as a homework. The instructor asked students to solve the given problems with the help of peer volunteers who had delivered peer teaching to them already.

The peer teaching made the students to interact with seniors and master's student easily and which bridged the gap between seniors and juniors in the department. As the lectures were completed and nearing to continuous assessment-1, students were asked to submit their assignment - 1 prior to the exam. In this regard, as per CDIO education pattern (conceive, design, implement and observe) students must understand the concept delivered in classroom and then they themselves must develop their own application related to the course content. As per course outcome 2 and 4, the instructor's ultimate aim was to encourage students to develop their own model or

Fig. 3 : Peer teaching for third year students by ME student.

group assignment that is to develop a prototype for their design. To implement this concept, students were assigned assignment -1 to design any individual system or industrial application using bond graph ideology and simulate the same in 20sim software. 20sim software was used to design bond graph of any system and implement to analyze the varying parameters in simulation itself.

B. Google Classroom Assignment

The Google classroom, an open source online application was introduced mainly focusing on school student's education.Later this application introduces in CBCS engineering and CDIO engineering syllabus for effective development of student skills in engineering colleges. Most of the faculties in Tamilnadu engineering colleges are aware of using ICT tools for their courses. Thus, these kinds of online platforms like Moodle, Teel, Plickers, canvas and Google classroom made students to do their assignments smartly in their courses. These kinds of online applications reduce time effectively and help in students' interaction with their mentors, instructors and peer volunteers easily and clarify doubts instantly. The Google application which requires students Gmail ids for registration and creates a classroom only for specific set of students who follow particular instructor for particular course. Since the classroom is created by instructor a unique code is generated and it is shared with student group who was instructed to join in that classroom as shown in the figure below.

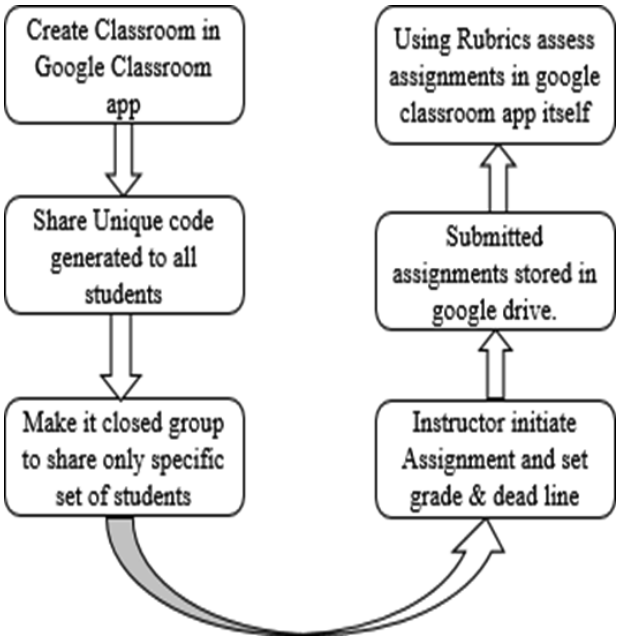

Fig.4 : Google classroom Application usage in online assignment.

Once classroom is created and student members were joined, the interaction about classes, lecture materials, eBooks, journal related to the topic could be shared among group in Google classroom. The advantage of using Google classroom is all the materials, contents, assignments can be stored; questions and interaction were also stored in Google drive as specific folder. The instructor easily identifies all assignment materials and validate the stipulated time.

5. Assessment Results

The teaching method involved ICT tool based lecturing techniques and conventional lecturing methods. Based on the comparison, the researcher explained that lecturing. This made the students to concentrate more on skill development than mark-based studying technique. Thus, instructor used the learner centric lecturing method for the mechatronics system design course method and thus they expect students to develop their own products related to mechatronics system applications. Thus, the student assignment -1 submitted in Google classroom was grouped and verified for duplication which is listed below. Once the process is over, the instructor validates the assignment based on following rubrics. In proposed curriculum framework the student transition rate is more important. So grading assignment must have appropriate rubrics. In Google classroom online submission assignments, the rubrics is framed and grade marks are divided in Classroom application itself. The figure 6 discuss about the adding extension option available in Google classroom for rubrics separation.

Thus, the instructor validates student cognitive and also psychomotor skills. Post assessment validation done by using Item analysis method through

Table 3: Assessment rubrics for Assignment-1 submission

S.No	Description	% of Marks
1	Mathematical model design	20%
2	Appropriate selection of actuators and sensors	20%
3	Designing model using 20 sim software	30%
4	Simulation result submission and explanation	20%
5	Presentation and communication skills	10%

calculation of Difficulty index (α), Discriminative index (β), Facilitation value (FV) and Effectiveness of Distractors (DE) [12]. The study was conducted in the department of mechatronics, 14MT620 Mechatronics system design course.

Fig.6 : Google Classroom Rubrics Creation for Assessment

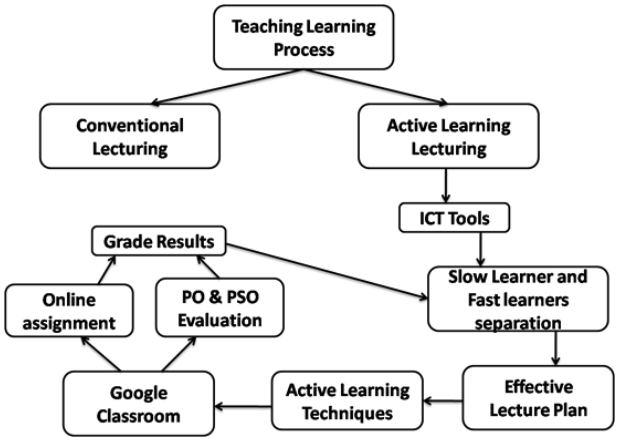

Fig.7 : Phase-1 and Phase-2 assessment block diagram

Table 4 : Formulae for Item based analysis [12]

Description	Formula	Explanation	Interpretation
Difficulty Index (**α**)	**α** =((H+L)/N)x100	H-No. of students correctly answer in upper grade group L-No. of students correctly answer in lower grade group N- Total number of two groups including non responder	**α** <30% -Difficult, **α** =30-70% -Accepted **α** > 70%= Not accepted (easy)
Discriminative index	β=(Ri-Rj)/N)x2	Ri- ∑ (no. of upper grade students x total marks obtained), Rj- ∑ (no. of lower grade students x total marks obtained)	β is –ve then β =0-0.19 poor β =02-0.29- acceptable β >0.3 excellent
Facilitation value (FV)	FV=(Ri + Rj)/N		
Distractor effectiveness (DE)	DE= (Nl-Nu/N)x2	Nl-no. of lower group students, Nu-no. of upper group students.	0-100% for MCQ's

Table 5. Results discussed about item-based analysis of online assignment phase-1

Iteration-1	A	B	C*	D	**Iteration-2**	A*	B	C	D
UPPER (27%)	3	1	11	0	**UPPER 27%**	9	4	0	2
LOWER (27%)	6	3	5	1	**LOWER 27%**	6	5	3	1
DE	0.2	0.133	-	0.066	**DE**	-	0.066	0.2	-0.1
α	53%	Since α, β, functionality showed in iteration are within the limit. Thus, no modification			**α**	50%	Since the α, β, functionality are within limit so this can be used without modification		
FV	0.53				**FV**	0.5			
β	0.4				β	0.2			
Iteration-3	A*	B	C	D	**Iteration-4**	A	B*	C	D
UPPER 27%	5	7	2	1	**UPPER 27%**	5	10	0	0
LOWER 27%	0	12	2	1	**LOWER 27%**	9	6	0	0
DE	-	0.33	0	0	**DE**	0.26	-	0	0
α	2%	The α value less than 30% so the question is misunderstood by the students and further modification in teaching method			**α**	53%	The α values are in acceptable level, thus lower students mostly prefer A option. In this iteration the discriminative value needs to modify		
FV	0.022				**FV**	0.53			
β	0.133				β	0.26			

The Class strength over 70 students who had submitted the assignment for assessing 10 marks was in the form of question and answer. There was no negative mark for this test response and the understanding category questions were given as multiple-choice questions (MCQ's) in phase-1 and the remaining are simulation-based submission in phase-2. Once the question along with course outcome mapping submitted before examination, the course designer along with head of department fix the pass mark as 5/10 mark (50%) through pre-validation of question.

At the end of the examination, overall response was collected from the students and they were used for post validation using Item analysis method. The post validation analyses required data or information based on total mark obtained by the individuals. The post validation was done in two phases where MCQ's questions are analyzed using item analysis and Application category simulated type questions were assessed by Google classroom or classical test theory. Then the students were given grades based on their performance. The upper 27% of students are grouped as upper graded students and lower 27% students are grouped as lower graded students [10]. The remaining category consisted of four set of options where one is correct and remaining three options are distractor. The statistical data were converted into mean, percentage, standard deviation for n items.

The relationship between α and β, DE and FV for the items is determined by correlation analysis. The item analysis results of course outcome group of questions were analyzed and categorized under accepted level and modification needed in discriminator or the teaching methodology were assessed and sample results were also formed which is displayed in table 5. The essay category questions were also analyzed based on the item assessment, complexity and remedial solutions which are shown in Table-6. The sample assignment submitted in Google classroom is shown in figure 8.

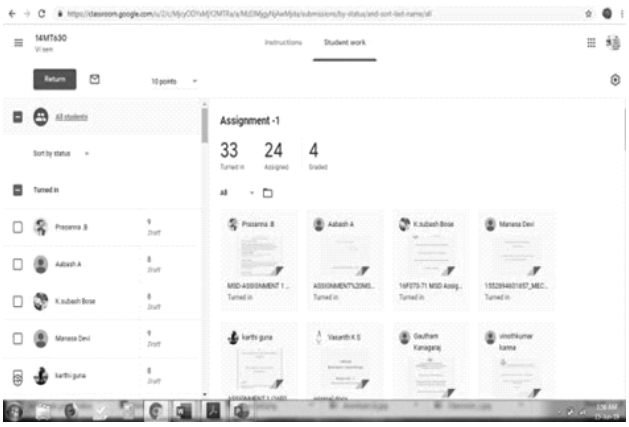

Fig. 8 :Sample assignment submission in Google classroom.

Finally, at the end of assessment the faculty members were asked students to provide feedback using Plickers application. Based on the feedback results shown in annexure-1 the students voluntarily come forward as team leader and trouble shoot others assignment problem and also peer teach the slow learners in the group itself. This kind of assignment not only assesses the student's performance but also develops the students' unity and team sprit with in classroom.

6. Conclusions

Thus, the introduction of online based assignment submission using interactive platforms like Google classroom, encourages the students to submit the assignment on time. Based on the classical analysis, item analysis and rubrics analysis methods, the submitted assignments are assessed and validated. Using item analysis method, a high facility value and low discrimination index value among class students responses segregates the student category as fast learners and slow learners (good and bad). This helps the instructor to adjust the teaching methodology and create impact over the fast and slow learners in classroom equally. The reliability and standard in setting of the course outcome helped to improvise the teaching plan and course objective in better way for ongoing other batch members in routine manner. The introduction of CDIO and innovative teaching tools among engineering students paved way for developing their hands-on skills from all courses by doing demonstration and simulations. As per survey, only 10-15 % of faculty members were found to work on post-validation results and come up with the remedial measures like introduction of ICT tools, MOODLE activities and product- based learning, Flipped classroom during this covid 19 crisis.

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Annexure-1

S.No	Survey statements	Better	To some extend	Moderate	Less
1.	Encourage to attend contact session throughout the topic.	53%	45%	2%	-
2.	Adequate depth knowledge coverage	64%	31%	3%	2%
3.	Triggered group learning activity	63%	36%	1%	-
4.	Motivate self-learning and self-assessment	54%	34%	8%	4%
5.	Evaluation of peer teaching activity	72%	26%	2%	-
6.	Motivate to learn topics through activity	47%	38%	10%	5%
7.	Willing to attend technical quiz actively	38%	44%	13%	5%
8.	Improve fearless defend against topics	46%	29%	24%	1%
9.	Develop soft skills through assignments	64%	22%	8%	6%
10.	Motivate to contribute more in group activity	54%	29%	13%	4%