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Transforming Learning Experiences: A Case Study of Integrating Contextual Teaching and Learning (CTL) in the Physics Course within a Bachelor of Technology Program

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***Abstract*—This paper explores the integration of Contextual Teaching and Learning (CTL) into a Physics course within a Bachelor of Technology program, emphasizing the influence of constructivism on educational practices. In the constructivist framework, learning is most effective when situated in authentic, meaningful contexts, enabling students to apply their knowledge to real-world problems and relate it to their lives. CTL facilitates this process by seamlessly integrating real-world contexts into the curriculum, fostering student exploration, analysis, and application of learning in relevant and meaningful ways. Notably, CTL can be implemented within a course without significantly altering the curriculum. The study underscores CTL's principles, particularly its capacity to bridge classroom content with real-world experiences, and outlines implementation strategies, including active learning methodologies. Student learning experiences in the Physics course through the implementation of CTL were surveyed. Data collection involved soliciting student feedback via Google Forms, revealing varying levels of engagement across course modules. Analysis of feedback demonstrates a positive perception of CTL, accompanied by suggestions for its enhanced implementation. The paper concludes with recommendations for future research and the effective integration of CTL into physics education.**

***Keywords*—active learning, constructivism, Contextual Teaching and Learning, Pedagogy, Physics, student–centred learning.**

***JEET Category*— Practice.**

I. INTRODUCTION

Learning theories examine the principles that govern how individuals acquire, retain, and acquire knowledge. Various learning theories are prominent within education, including behaviorism, cognitivism, *constructivism*, experiential learning, humanism, pedagogy, andragogy, and collaborative learning.

Teaching methods, which refer to strategies used by educators to facilitate learning, are broadly divided into three types: teacher-centered, student-centered, and content-centered interactive approaches. Commonly defined as teaching methodology, pedagogy encompasses both theory and practice related to learning and examines how this educational process is shaped and shaped by the social, political, and psychological development of students. These elements – learning theory, teaching methods and pedagogy – complement each other in the educational sphere (Joshi, 2021; Li, 2006).

Constructivism

Constructivism is a philosophical and psychological viewpoint that contends that people actively create meaning by relating new concepts or experiences to what they already know. Two pioneer contributors to the development of constructivist theories are Jean Piaget and Lev Vygotsky (Taber, 2019; Pakpahan & Saragih, 2022; Shabani & Ebadi, 2010). Though their philosophies differ and there are disagreements in how constructivism should be used in classrooms, they both agree that classrooms ought to be constructivist settings (Sumarna & Gunawan, 2022). They emphasized that individuals actively construct their understanding of the world through experiences and interactions, leading to the development of student-centered learning approaches (Alam, 2023). This shift from teacher-centered to student-centered paradigms encouraged the use of multisensory learning experiences and scaffolded learning environments, promoting meaningful learning over rote memorization (Bada & Olusegun, 2015). Additionally, constructivism advocates for the integration of emotion and reason in learning processes, fostering emotional intelligence and humanization in educational settings. Overall, the work of these pioneers, Jean Piaget and Lev Vygotsky, laid the foundation for modern educational practices that prioritize

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active engagement, critical thinking, and the construction of knowledge through personal experiences and interactions.

Crafting Constructivism

Constructivism is a broad theoretical perspective that encompasses various approaches across different disciplines, including philosophy, psychology, sociology, and education. Here are some of the different types or branches of constructivism (Gunstone, 2015; Zajda & Zajda, 2021).

a) Cognitive Constructivism: Focuses on how individuals construct knowledge through experiences and interactions.
b) Social Constructivism: Influenced by Lev Vygotsky, emphasizes the social and cultural aspects of learning.
c) Radical Constructivism: Asserts that knowledge is subjective and constructed by individuals.
d) Critical Constructivism: Combines elements of critical theory with constructivist principles.
e) Technological Constructivism: Views technology as a medium that shapes and mediates learning experiences.
f) Radical Social Constructivism: Asserts that knowledge is shaped by social interactions and language.

Constructivism encompasses various disciplines, offering distinct perspectives on knowledge construction, understanding, and application in diverse contexts.

Constructivism in higher education

In the context of higher education, constructivism plays a crucial role in modernizing educational spaces and promoting self-regulated learning through personal learning environments. The theory of constructivism has been particularly important in the digital age, shaping new forms of learning and redefining the roles of teachers in facilitating knowledge transfer. Its impact on teaching practices has been evident in promoting creative thinking, student engagement, and the adoption of innovative pedagogical strategies (Almulla, 2023, Dixit, et. al., 2024). Constructivism is a methodological basis for active learning that promotes integrative and interdisciplinary connections in education, emphasizing lifelong learning and the need for a change in teaching models (Doychinova, 2023).

Teaching strategies that align with constructivist principles focus on creating environments that allow learners to engage actively in the learning process. Effective teaching strategies based on constructivism learning theory include active learning, project-based learning, cooperative learning, and the use of technology and approaches adjusted to changes in the learning process. The constructivist approach to teaching and learning is student-centered, participatory, and nurtures active learning (Koptseva, 2020). Teachers should combine constructivism theory with existing teaching methods and create scenarios to think about subjects from the perspective of students' psychology. The social constructivist approach highlights learners' autonomy, reflective thinking, problem-solving, collaborative learning, scaffolding, and discussion and debates as major learning principles. Constructivist pedagogy can promote social interaction, academic standards, and education quality in inclusive classrooms, with a range of effective strategies for enhancing meaningful learning and improving academic standards (Sharma & Bansal, 2017).

This shift towards active student-centered learning is particularly salient in engineering education, where constructivism includes both educational theory and the actual practice of teaching. Constructivism encourages engineering students to construct knowledge in cooperative endeavors such as robotics, design labs, and software-based projects. These environments valorize autonomy, teamwork, and problem-solving, which are utterly essential skills for success in the working world. Methods such as project-based learning, Peer – Peer learning, and technology integration support interdisciplinary understanding and promote lifelong learning habits. Makerspaces and prototyping tools epitomize constructionist learning because they give students a chance to visualize their ideas and reflect upon them in a real-world context. Contextual Teaching and Learning (CTL) as one more instance of the practical application of constructivism further ties this engineering course content to real-life examples, leading to deeper engagement, meaning-making, and collaborative knowledge construction (Azfar Khalid et al., 2023)

Contextual Teaching and Learning (CTL) is one of such learning approaches that emphasizes the importance of social interactions, cultural context, and language in knowledge construction. It connects instructional content to real-world experiences and problems, encouraging students to actively construct their understanding through interactions with their environment and peers. CTL often involves collaborative learning activities, where students work together to solve problems, share perspectives, and construct new knowledge. This approach aligns with social constructivist principles, despite drawing elements from cognitive constructivism and other constructivist perspectives (Sumarna & Gunawan, 2022).

Outline of CTL

Contextual Teaching and Learning is a concept of learning that aims to create meaningful connections between classroom content and real-world situations, thereby enhancing student engagement and understanding. Proponents of CTL believe that by connecting classroom learning to real-life experiences, students are better able to grasp and retain complex concepts. This approach encourages students to apply their knowledge to solve problems and make informed decisions in various contexts. In the classroom, teachers often utilize real-world examples, case studies, and hands-on activities to help students see the relevance of what they are learning (Hudson & Whisler, 2007).

One key aspect of CTL is the recognition of diversity among students. By acknowledging and incorporating students' diverse backgrounds, experiences, and perspectives into the curriculum, CTL aims to create a more inclusive and personalized learning environment. This approach not only fosters a sense of belonging for all students but also enriches the learning experience by drawing on the richness of different cultures and perspectives (Tari & Rosana, 2019).

The components of contextual teaching and learning CTL include *constructivism, inquiry, questioning, learning community, modelling, reflection, and authentic assessment*. CTL aims to link the material being taught with real world situation, making learning meaningful and engaging for students (Kurniasih, 2021). By incorporating these components, CTL helps students associate lessons with their life contexts, improving conceptual understanding and encouraging active participation in the learning process. Additional, CTL based on the values of Tri Hita Karana has been found to positively impact students' knowledge competency in science subjects, providing an alternative model for enhancing learning outcomes (Kristidhika, et al., 2020).

Indeed, the Contextual Teaching and Learning approach gives real-world relevance and interdisciplinary connection to the curriculum. Hence, in a way, it has always been a mover and shaker in the teacher training arena while emphasizing active student involvement, reflection, and student-centered strategies. On a policy level, CTL is aligned with such frameworks as NEP 2020 in supporting competency-oriented and experiential learning. CTL offers a broader and more integrative perspective than many approaches, with respect to project or inquiry-based learning, embedding context into all aspects that come to bear on instruction: content, learning environment, and assessment. For instance, since CTL apparently extends beyond projects and problems, it deepens conceptual understanding, transferability, and contextualization, according to Johnson E.B. (2002).

Implementation of CTL

Indrayati & Kuni (2022) conducted a study with the aim of enhancing students' competence in understanding concepts and theories of accounting information systems, as well as improving their achievement and learning outcomes through innovative contextual learning methods. The research involved the evaluation of applications using survey questionnaires.

The implementation of Contextual Teaching and Learning (CTL) in students has shown that CTL enhances higher–order thinking skills (HOTS) in writing abilities, leading to improved student learning outcomes (Hakim & Sari, 2023). The CTL has been effective in improving student achievement in specific subjects like Arabic and mathematics, surpassing conventional learning methods. (Hayati et al., 2022). Additionally, the research comparing project-based and mixed courses in science education found that project courses tend to provide more satisfaction in autonomy, competence, and relatedness, highlighting the importance of balancing autonomy and structure to maintain student motivation (Kostøl & Remmen, 2022).

At the undergrad level, the author implements contextualization, problem-based learning, group work, and formative assessment to teach undergraduate database models effectively, enhancing students' engagement and understanding (Xue, 2014). Hanik et al., 2018 employed contextual teaching and learning (CTL) in conjunction with observation methods to augment learning outcomes in the Basic Ecology subject among university-level students. Zuhrie et al., 2019 endeavored to construct robots for electrical engineering students, employing CTL principles to integrate theoretical concepts with practical application. After six years of development and validation involving diverse experts, the resulting robotics learning module demonstrates notable enhancement in construct validity, indicating improved student learning outcomes. Becerra et al. (2022) assess the impact of contextualization courses in engineering, inspired by sociotechnical thinking, on students' comprehension of technology's social dimensions and their enhancement of analytical skills for socially impactful engineering practices.

Investigation into the integration of Contextual Teaching and Learning (CTL) in undergraduate education has received limited attention in academic discourse. This scarcity of research may stem from the diverse nature of undergraduate subjects, each with its unique characteristics, leading to varied teaching approaches and adaptations of CTL across disciplines. In this study, the author specifically concentrates on integrating the CTL method into the teaching of Physics courses for first-year B.Tech students. The focus is guided by specific Research Objectives (RO), outlined as follows:

RO1: How does the implementation of Contextual Teaching and Learning (CTL) methodology impact student engagement and understanding of the physics subject in engineering education?

RO2: How does the CTL approach enhance students' ability to apply physics concepts to real-world situations and problems?

RO3: What are the perceived benefits and challenges of integrating CTL into the physics curriculum for first-year B.Tech students?

RO4: What teaching strategies and activities are most effective in facilitating student learning and comprehension within the CTL framework?

II. DATA COLLECTION

Implementation of CTL requires careful planning and integration of various instructional strategies as per the requirements of the subject. The instructor has taken care to design learning experiences that connect with students' prior knowledge and experiences, as well as with the world outside the classroom. The best part of the CTL method is that it can be implemented in the classroom without alteration of the syllabus/curriculum. Assessments should also align with the contextual approach, allowing students to demonstrate their understanding in practical and meaningful ways.

The implementation of CTL is carried out in a tier-1 engineering college located in Pune, Maharashtra, India. This academic autonomous educational institution is affiliated with Savitribai Phule Pune University. Offering a comprehensive four-year Bachelor of Technology (B.Tech) program, the college provides specialized instruction across five distinct branches, namely Electronic and Communication Engineering, Computer Engineering, Information Technology Engineering, Mechanical Engineering, and Instrumental Engineering.

During the academic year 2022-23, semester I, the initiative was taken for the implementation of Contextual Teaching and Learning (CTL) methodology within the framework of the Physics course. The designated course code for this initiative was 20BS04 Physics (the first number 20*20*, the year in which the course was introduced, BS stands for Basic Sciences and 04 is the subject code). Specifically, the CTL approach was introduced to first-year B.Tech students enrolled in the Electronic and Communication Engineering branch, specifically within division B, encompassing a cohort totalling 66 students.

The 20BS04 Physics course spans a duration of 14 weeks, encompassing both In–Semester (ISE) and End-of-Semester (ESE) examinations. The course is structured into five modules, each addressing distinct topics related to broad areas of physics namely optics, statistical physics, Thermodynamics and Modern Physics. These modules are:

Module I: Electromagnetic radiation and interference.

Module II: Diffraction and Polarization.

Module III: Statistical Physics and Thermodynamics.

Module IV: Quantum Physics

Module V: Properties of Solids.

The primary textbook utilized for this course is the "Feynman Lecture in Physics" (FLP) comprising volumes 1 through 3, supplemented by the reference book "Principles of Physics", Wilsey Student Edition (10th Edition) authored by J. Walker, D. Halliday and R. Resnik and "University of Physics", Pearson Addison Wesley (12th Edition) authored by H. Young and Roger Freedman.

At the outset of the course, students are acquainted with the course's objectives and expected outcomes. Before the beginning of the course, students were provided with a comprehensive explanation of the planned implementation of the Contextual Teaching and Learning (CTL) pedagogy. This involved detailing the methodology's principles and objectives, ensuring students were well-informed and prepared for the instructional approach to be employed throughout the course. Initial lectures serve to bridge prior knowledge acquired during secondary education with the trajectory of the 20BS04 Physics course. A Google Classroom platform is established to facilitate communication and dissemination of course-related updates.

Preceding the beginning of every module, let's say Module 2 (Diffraction and Polarization) and Module 4 (Quantum Physics), a Module Google Form is circulated through the Google Classroom platform well in advance. This Module Google form is designed to elicit student perspectives on the applications of the respective topics. For Module 2, the questionnaires shared had responses in Text format. The questionnaires are listed in TABLE I.

Similarly, for Module 4, students are required to articulate their views on the significant applications of Quantum Physics and nominate a specific application of personal interest for deeper exploration within the classroom settings. Students engage in independent research via internet resources to formulate their responses to the Module Google Form queries.

TABLE I
QUESTIONNAIRES TO ELICIT STUDENTS' OPINIONS ON THE MODULE'S APPLICATIONS

Sr. NO	Questionaries
01	Enter college U - Number (write completely say UEC2022205)
02	Name of the Student
03	Did you explore the applications of *Diffraction and Polarization?*
04	Give a *BROAD Class* where you feel *Diffraction* is significantly used in science/industry/daily life.
05	Give one *Application* under the *BROAD class* of *Diffraction* you feel is significant to learn.
06	Give a *BROAD Class* where you feel *Polarization* is significantly used in science/industry/daily life.
07	Give one *Application* under the *BROAD class* of *Polarization* you feel is significant to learn.

Notably, their submissions not only enumerate broad categories of applications but also highlight particular applications that have captivated their interest, thereby informing subsequent classroom discussions and instructional content (Blaschke, 2021).

The aim of acquainting students with the practical relevance of the upcoming module is achieved through the analysis of responses obtained via the Module Google Forms. This instructive endeavor serves to foster student engagement with the subject matter (Blaschke, 2016). Additionally, during the initial phase of the module within the classroom setting, deliberations on real-world applications are conducted. As previously elucidated, a notable attribute of the Contextual Teaching and Learning (CTL) approach is its seamless integration within existing syllabi and curricula. The discourse on physics concepts within the syllabus is contextualized by real-world applications. Consequently, students not only acquire comprehension of physics principles but also establish meaningful associations with real-world scenarios.

It is evident that due to the breadth of physics, not all its applications can be exhaustively discussed within a particular branch. However, following classroom discussions, attention was drawn to the real-life applications of the physics concepts to be imparted, after which these concepts were elaborated upon. The active learning approach (Patil & Dharwadkar, 2020; Patil & Chavan, 2020) implemented within the classroom setting facilitated a dynamic instructional environment throughout the semester, characterized by a wide range of active learning pedagogies. These methodologies comprised *group discussions, utilization of the flipped classroom model, integration of Think-Pair-Share activities, and incorporation of argumentation exercises*. By integrating a spectrum of active learning methodologies, the classroom environment was transformed into a dynamic space conducive to interactive and collaborative learning experiences (Pusawale, 2020). Group discussions provided opportunities for students to exchange ideas and perspectives, while the flipped classroom model encouraged independent exploration of course content outside of traditional lectures. Think-Pair-Share activities facilitated peer-to-peer learning and reflection, fostering deeper engagement with the real-life scenarios. Additionally, the inclusion of argumentation exercises promoted the development of analytical reasoning and communication skills.

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An activity example, Module 2: Diffraction and Polarization sets students up for some real-life applications of the subject as part of their pre-class assignment. In class, an enjoyable and meaningful activity takes place whereby each student identifies a unique application of polarization and diffraction, and explains how it relates to the concept. Students join each other at the desk with peers from which they were assigned to spend time discussing the applications that they found. Thus, each learner learns about an application they found from their peer. Approximately 20 minutes take up this activity.

This was followed by a discussion in class engaging all students, with different applications of diffraction and polarization brought out. Then, the instructor connects the application back to the fundamental principles and theories underlying these applications. This manner of teaching also helps the student to relate to the phenomenon and technology that he or she has been encountering, thus making learning most relatable and fun.

Then, the instructor spends another 20 minutes on the theoretical aspects that he wishes to highlight concerning this module and which they are going to learn in the module. For the entire activity, the instructor observes students' participation and involvement in the program while encouraging every student to participate constructively. This kind of learning through peer interactions not only encourages participation but also promotes a fuller understanding of the topic through real-life connections. All of these above activities covered in the course were mapped to Question 6 of Table III of the CTL Feedback Google Form that was circulated at the end of the course. Therefore, this mapping gave rise to some significant findings about the effectiveness and impact of these activities. Furthermore, the Google Classroom platform was utilized to distribute a variety of supplementary materials, including videos, concise scientific articles, and historical narratives detailing the development of applications. These resources were periodically shared alongside the study materials corresponding to each module. Active learning ensures the comprehensive execution of all components of CTL which includes constructivism, inquiry, questioning, learning community, modelling, reflection, throughout the CTL process.

As emphasized, assessments should be congruent with the contextual approach, providing students with opportunities to showcase their comprehension through practical and significant means. After discussions or teachings within a module, problems—whether numerical, analytical, or both—were formulated to closely resemble real-life applications and were addressed during class sessions. These problem-solving exercises were designed to operate at various cognitive levels within Bloom's taxonomy, allowing for critical analysis and evaluation of concepts. Both the Internal Semester Examination (ISE) and End Semester Examination (ESE) were structured around problem-based assessments, reinforcing the application-oriented nature of the course content.

At the conclusion of the course, feedback on both the Contextual teaching and learning CTL process and the instructor of the 20BS04 Physics course was collected. Thus, the students were surveyed via Google Form regarding their perceptions of the implementation of contextual teaching and learning pedagogy.

The Module Google Form, as depicted in Table I, is for one of the modules, module 2, Diffraction and Polarization, and as stated earlier on similar lines all the other four modules have been designed. These Google Forms were then circulated through the Module Google Classroom platform to gather their responses and insights regarding their independent research on the applications related to each module at the beginning of teaching of each module. Through this form, students are prompted to reflect on their findings, identifying broad categories of applications and highlighting specific ones that have intrigued them personally. Table II shows the number of students' responses (out of a total of 66 responses) for each module.

Towards the conclusion of the course, a Google Form was circulated to gather feedback and responses concerning the implementation of Contextual Teaching and Learning (CTL) pedagogy and the instructor's performance. These insights are subsequently examined and discussed within the data analysis and interpretation section.

TABLE II
STUDENT ENGAGEMENT LEVELS ACROSS PHYSICS COURSE MODULES

Module	Title	Number of Student Responses
I	Electromagnetic radiation and interference	52
II	Diffraction and Polarization	50
III	Statistical Physics and Thermodynamics	60
IV	Quantum Physics	62
V	Properties of Solids	61

III. DATA ANALYSIS AND INTERPRETATION

The data from Table II. reflects varying levels of student engagement across different modules in a physics course, gathered through a Module Google Form on the Google Classroom platform.

The rise in student numbers as modules progress indicates a growing interest in the learning journey. Quantum Physics garnered the highest response rate, indicating significant student interest, followed closely by Statistical Physics and Thermodynamics and Properties of Solids. Electromagnetic Radiation and Interference received notable engagement, while Diffraction and Polarization saw slightly lower interest. These findings underscore the importance of aligning course content with student interests to optimize engagement and learning outcomes in physics education.

A CTL feedback Google Form was distributed to collect feedback and responses on the implementation of Contextual Teaching and Learning (CTL) pedagogy and the instructor's performance, utilizing a 5-point Likert scale. A Likert 5-point scale is a tool used in surveys where participants are asked to express their agreement or disagreement with a statement. It offers five response options ranging from "strongly agree" to "strongly disagree," with three intermediary choices indicating different levels of agreement or disagreement. Likert scales are commonly employed in educational surveys because of its simplicity, quantitative character, and adaptability. They provide an easy-to-understand style for respondents to express their ideas on a continuum, allowing for more refined data collection (Joshi et al., 2015). Table III provides an overview of the questionnaires presented in the CTL feedback Google Form. The table outlines the specific inquiries and the nature of the response expected. The research objectives (*ROs*) of this study are to investigate the impact of Contextual Teaching and Learning (CTL) methodology on physics education in engineering programs. *RO1* explores CTL's impact on student involvement and comprehension, with responses to questions 2 and 3 giving valuable insights. *RO2* investigates how CTL improves students' capacity to apply physics principles to real-world circumstances, as posed by questions 4 and 5. *RO3* focuses on the perceived benefits and obstacles of incorporating CTL into the curriculum, as demonstrated by the response to question 6. *RO4* seeks to find effective teaching practices within the CTL framework, with questions 8 and 9 leading the investigation. This structured approach seeks to comprehend the instructional practices required for the successful implementation of the CTL method for the physics course in engineering education.

TABLE III
ASSESSING CTL AND INSTRUCTOR EFFECTIVENESS IN PHYSICS LEARNING EXPERIENCE FEEDBACK QUESTIONNAIRE.

Sr. No	Questionnaire	Nature of response
	CTL Feedback	
1	Level of effort YOU put into the course	Poor, Satisfactory, Fair, Very good, Excellent.
2	The discussions carried out at the start of every module motivated you to learn.	Strongly disagree, Disagree, Neutral, Agree, Strongly agree
3	You explore the diverse real-life applications - contexts related to every module.	Strongly disagree, Disagree, Neutral, Agree, Strongly agree
4	Did you recognize that learning a concept in the course, could be applied in multiple real-life applications?	Strongly disagree, Disagree, Neutral, Agree, Strongly agree
5	Did the CTL learning process help you to become a self-regulating learner?	Strongly disagree, Disagree, Neutral, Agree, Strongly agree
6	During the CTL learning Process, various activities such as Flipped classroom, Think pair share and argument, and discussions, conducted in class, helped you to compare, analyze, evaluate, and to some extent give solutions to the real-life problems.	Strongly disagree, Disagree, Neutral, Agree, Strongly agree
7	Do you recommend taking the CTL method for future learning students?	Yes/No
8	The strength of the implemented CTL Learning Method	Text
9	Improvement of the implemented CTL Learning Method	Text
	Instructor Feedback	
10	GOOD😉👌- about the instructor	Text
11	Suggestions for Improvement🏋‍♀ - to the instructor	Text

CTL Feedback

1. Teaching-learning is a two-way process. Along with the involvement of the instructor the student's active involvement in a course is equally significant. The question, *Your Level of effort in this course*, serves as a general inquiry into the student's level of effort invested in the course. By asking about their effort, the aim is to understand their overall engagement and commitment to learning.

Fig. 1.

Respondents' ratings as shown in the Figure. 1., ranging from "Poor" to "Excellent," were distributed as follows: "Poor" accounted for 0%, "Fair" at 3.3%, "Satisfactory" at 14.52%, "Very good" at 21.78%, and "Excellent" at 3.96%. The majority of students reported a satisfactory to excellent level of effort invested in the course, indicating a positive engagement with the learning process.

2. Recognizing the potential impact of discussions on motivation, the question, *The discussions carried out at the start of every module motivated you to learn*, aims to assess if students found the introductory discussions effective in stimulating their interest and enthusiasm for the upcoming module content.

In response to the statement, 'Strongly disagree, Disagree, Neutral, Agree, and Strongly Agree,' 69.7% of participants agreed, while 30.3% strongly agreed, with no respondents indicating disagreement or neutrality as seen in Figure. 2. The survey findings indicate overwhelming agreement among students (69.7%) regarding the motivating effect of introductory discussions at the onset of each module, with an additional 30.3% strongly affirming their efficacy, reflecting a unanimous perception of the discussions' positive impact on fostering interest and enthusiasm for the upcoming content.

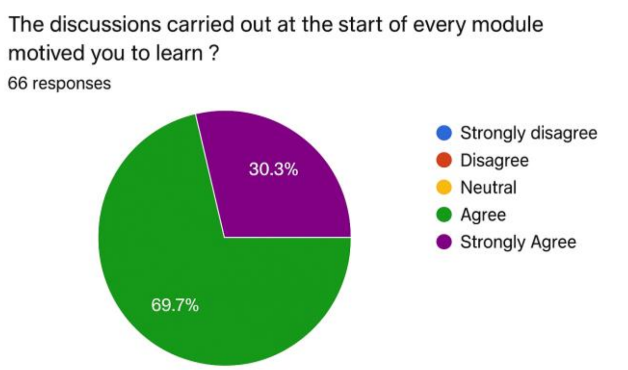

Fig. 2.

3. By highlighting the importance of real-life applications, the question, *You explore the diverse real-life applications - contexts related to every module*, aims to gauge if students actively sought out connections between course concepts and practical scenarios. It aims to assess their ability to contextualize their learning in real-world contexts.

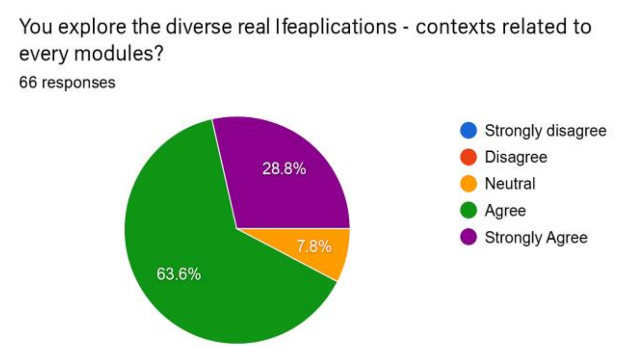

Fig. 3.

In percentage-wise responses were: Strongly Disagree 0 %, Disagree 0 %, Neutral 7.6 %, Agree 63.6 %, Strongly Agree 28.8 %. These percentages indicate varying levels of agreement among respondents regarding their engagement in exploring diverse real-life applications and contexts related to each module. Notably, as seen in Figure. 3., a significant portion of participants, 28.8%, expressed strong agreement with actively seeking connections between course concepts and practical scenarios, highlighting a robust inclination towards contextualizing their learning in real-world contexts.

4. Understanding the transferability of knowledge is crucial. The question, *Did you recognize that learning a concept in the course could be applied in multiple real-life applications*, seeks to ascertain if students grasped the versatility of course concepts and understood their potential application in various real-life situations.

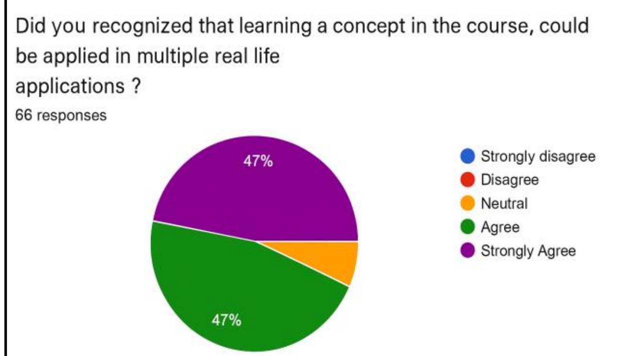

Fig. 4.

Percentage-wise responses as seen in the Figure. 4., were strongly disagree 0 %, disagree 0 %, Neutral 6 %, Agree 47 %, Strongly Agree 47 %. The responses show that a majority of students, 47% each, strongly agree and agree, indicating widespread recognition of the practical relevance of course concepts. However, 6% remain neutral, possibly due to uncertainty about practical applications or unawareness of transferability. Thus, most students perceive knowledge transfer positively, suggesting alignment between course content and real-world utility.

5. Self-regulation is a key aspect of effective learning. By asking, *Did the CTL learning process help you to become a self-regulating learner*, aims to understand if the course structure and activities facilitated the development of independent learning habits.

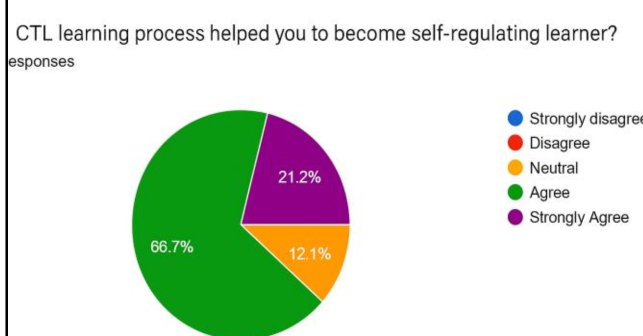

Fig. 5.

Percentage-wise responses as seen in Figure. 5., were Strongly disagree 0 %, Disagree 0 %, Neutral 12.1 %, Agree 66.7 %, Strongly Agree 21.2 %. The percentage-wise responses reveal a positive trend: a significant majority of 66.7% agreed, while 21.2% strongly agreed with the statement. This indicates that a large portion of students believe that the CTL learning process indeed contributed to their development as self-regulated learners. Their agreement suggests that they found the course structure and activities conducive to fostering independence and self-regulation in their learning journey. However, 12.1% of respondents expressed a neutral stance, neither agreeing nor disagreeing. This minority may have varying reasons for their neutral response, such as mixed experiences with the course structure or uncertainty about its impact on their self-regulation skills.

6. The question, *During the CTL learning process, various activities such as Flipped classroom, think pair share, argument, and discussions, conducted in class, helped you to compare, analyze, evaluate, and to some extent give solutions to real-life problems*, aims to evaluate the effectiveness of specific learning activities in promoting critical thinking, analysis, and problem-solving skills. It seeks to assess if these activities contributed to students' ability to engage with and apply course concepts to real-life situations.

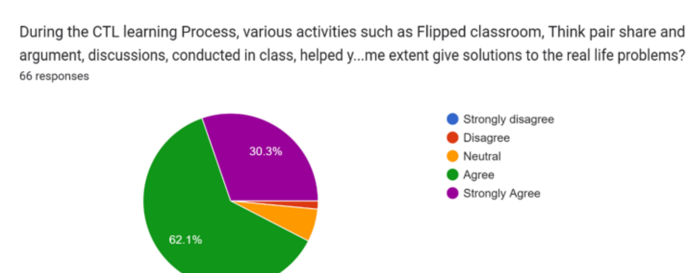

Fig. 6.

Percentage-wise responses as seen in the Figure. 6., were Strongly disagree 0 %, Disagree 1.5 %, Neutral 6.1 %, Agree 62.1 %, Strongly Agree 30.3 %. The percentage-wise responses indicate a predominantly positive outlook: a notable 62.1% agree, while 30.3% strongly agree with the statement. This suggests that a substantial majority of students believe that the mentioned activities indeed enhanced their critical thinking and problem-solving abilities, enabling them to engage with and apply course concepts to real-life scenarios effectively. On the other hand, only a small percentage, 1.5%, disagreed, and 6.1% expressed a neutral stance. These responses suggest that a minority of students either found the activities less effective in promoting critical thinking and problem-solving or were uncertain about their impact.

7. Drawing from students' experiences, this question, *Do you recommend taking the CTL method for future learning students*, aims to gather their perspective on the suitability and effectiveness of the CTL method for future learners. Their recommendation could provide valuable insights for course improvement and future implementation.

Percentage-wise the responses as seen in Figure. 7., were: Yes 97 % and No 3 %. The responses indicate an overwhelmingly positive endorsement of the CTL method, with 97% of students recommending it for future learners. This high percentage suggests a strong belief among students in the effectiveness and suitability of the CTL approach. Their recommendation likely stems from positive experiences and perceived benefits gained from engaging with this method. Conversely, only a small minority, 3%, expressed a negative recommendation. While this percentage is relatively low, it still represents a subset of students who may have encountered challenges or limitations with the CTL method during their learning experience. the overwhelmingly positive recommendation for the CTL method from the majority of students suggests a high level of satisfaction and perceived effectiveness. These insights are crucial for informing future course enhancements and implementations to further optimize the learning experience for students.

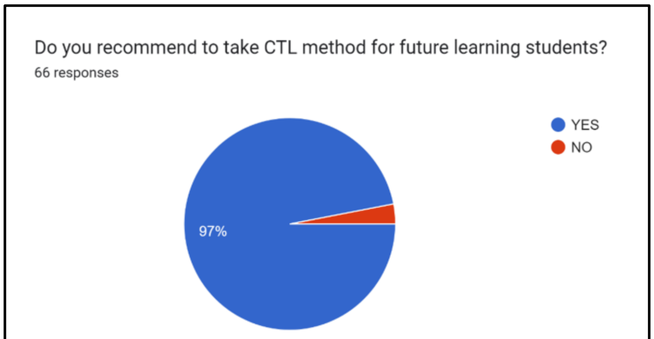

Fig. 7.

8. The question, *The strength of the implemented CTL Learning Method*, aims to gauge students' perception of the effectiveness and strengths of the implemented Collaborative Learning Theory (CTL) method. By asking about their views regarding its strength, I aim to understand which aspects of the method were particularly beneficial or impactful for them.

Based on the student's responses, the feedback on the CTL teaching method can be categorized as follows:

Strengths of the CTL Learning Method:

- Engages interest and maintains engagement throughout the lectures.
- Provides a helpful and effective way to improve knowledge and understanding.
- Makes concepts clear and enhances understanding of the topic.
- Encourages exploration, self-learning, and presentation skills development.
- Promotes interactive learning, peer discussion, and communication between students and teachers.
- Facilitates timely management of studies and increases interest in learning.
- Supports answering real-life questions with the help of physics and motivates deeper exploration.
- Enables students to relate concepts to daily life, broadening their perspective and making learning more practical and relevant.
- Utilizes visuals, animations, and discussions to enhance comprehension and application-based knowledge.

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- Fosters a conducive learning environment for active group work and knowledge construction.

Area for Improvement: Some students express the need for further improvement, particularly in terms of making lectures easier to grasp and incorporating more real-life examples. Others suggest enhancing the exploration aspect and ensuring clarity in understanding concepts. A few students mention the need for continuous exploration and expression of opinions to maximize the benefits of the CTL method.

Students perceive the CTL teaching method as highly beneficial, effective, and engaging for learning physics. They appreciate its ability to clarify concepts, promote exploration, and encourage active participation. However, they also highlight areas for refinement, such as improving lecture clarity and incorporating more real-life examples, to further enhance the learning experience.

9. By inquiring about the improvement *of the implemented CTL Learning Method*, the aim is to assess whether students believe that the CTL learning method has evolved positively throughout the course. This question seeks to understand if any adjustments or adaptations to the method were perceived as beneficial by the students.

Based on the feedback provided by the students, it can be grouped into the following:

Interactive Learning Experience: Some students express a desire for a bit more interactivity in the learning process, suggesting that more class interaction and participation could enhance their understanding and engagement with the material. They also highlight the importance of activities that encourage student involvement and stimulate discussions, such as group assignments and peer feedback sessions.

Application of Concepts: Many students appreciate how the CTL Learning Method helps them perceive the real-life applications of physics concepts, indicating that it enhances their understanding and relevance of the subject matter. They emphasize the importance of practical examples and activities that allow them to explore new concepts independently, fostering a deeper connection between theory and real-world scenarios.

Effectiveness of Current Method: A significant portion of students express satisfaction with the current implementation of the CTL Learning Method, stating that it is well-organized and effective in clarifying concepts. They believe that no major improvements are necessary, as the method already makes the course interesting and enjoyable for them.

Areas for Improvement: Areas for Improvement: Despite an overall positive evaluation of the learning experience, certain students have offered constructive feedback aimed at further enhancing educational outcomes. Key suggestions include the provision of supplementary resources such as instructional videos, augmentation of interactive activities, and enhancement of study material clarity. Moreover, there is a recommendation for the integration of practical knowledge discussions and encouragement of voluntary participation to deepen comprehension and engagement levels.

Furthermore, students have suggested a methodological improvement in which instructors ensure everyone's involvement by providing motivations for participation in the form of credits or marks for work completed in an active learning environment. Students also emphasize how important it is to match educational methods with industry standards, supporting the inclusion of in-depth case studies or industry-specific projects to support the development of practical skills and enhance workforce preparedness.

Peer learning has developed as a focal point of student recommendations, with a focus on its exclusive integration into active learning approaches. Furthermore, students urge for the inclusion of activities such as reading and discussing research articles in class, which build critical thinking and analytical skills while encouraging intellectual discourse among peers.

Instructor Feedback:

Successfully CTL implementation requires the instructor to be attentive and proactive. He must comprehend the diverse needs of their students and tailor instructional activities accordingly. The effectiveness of any pedagogical approach hinges not only on student engagement but also on the instructor's role. Here, students provide feedback about the instructor's performance in this course.

10. The question, *GOOD😊👌 - about the instructor*, aims to elicit positive feedback about the instructor. By using emojis and positive language, it creates a welcoming and encouraging atmosphere for students to express their appreciation for the instructor's teaching style, support, or other positive attributes.

Given that the query pertained to the instructor, with an (*in*)direct correlation to the CTL implementation of the course, detailed responses were not provided. Nevertheless, the essence of the responses is encapsulated in the subsequent paragraph.

The instructor created a supportive and engaging atmosphere and positive language. Students appreciate his good sense of humor and in-depth knowledge, which keeps the class interested and increases their thinking capacity. The instructor's interactive teaching style, clear communication, and focus on real-life applications make physics enjoyable to learn, encouraging exploration and fostering a deeper understanding among students. Thus, students find the instructor approachable, supportive, and enthusiastic, contributing to a positive learning experience and a keen interest in physics.

11. Constructive feedback is essential for continuous improvement. By asking, *Suggestions for Improvement🏋♀ - to the instructor*, this question encourages students to provide constructive criticism or recommendations for the instructor's improvement. It aims to foster a supportive environment for open communication and growth.

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The question prompts students to offer constructive feedback for the instructor's improvement, fostering an environment of open communication. While some students have no suggestions, others offer minor recommendations like adding more interaction. Overall, most students express satisfaction with the teaching methods and find no need for significant improvements, highlighting the instructor's effectiveness and supportive nature.

CONCLUSION

In conclusion, the feedback gathered from students regarding the implementation of the Contextual Learning Theory (CTL) method in the Physics B.Tech program offers valuable insights into the strengths and areas for improvement of the teaching CTL approach. Students overwhelmingly recognize the benefits of the CTL method, highlighting its effectiveness in engaging interest, improving understanding, and fostering interactive learning experiences. However, students also provide constructive suggestions for improvement in the implementation of CTL. These recommendations underscore the importance of continuous refinement to optimize the CTL method for enhanced student learning outcomes

Thus, the feedback indicates a positive reception of the CTL method among students, coupled with a willingness to collaborate and provide input for further enhancement. By incorporating these insights into future teaching practices, educators can continue to create a supportive and engaging learning environment conducive to student success and academic growth.

Enhancing CTL Implementation

In my capacity as the course instructor, I advocate for the following enhancements to be integrated into the improvement of Contextual Teaching and Learning (CTL) for future Physics courses:

a) Understanding that different disciplines have different requirements for improvement, it is clear that there is no one-size-fits-all method for enhancing contextual teaching and learning (CTL). The flexibility to adapt their teaching strategies to the particular requirements of various student groups and course topics must be granted to the instructor. This flexibility allows CTL delivery techniques to be adjusted for age group variations, subject complexity, and time constraints.

b) Implementation of a CTL structure where marks or credits are allocated to each activity within the course, incentivizing active participation and engagement.

c) Expansion of assessment methods beyond traditional pen-and-paper exams to include In-semester exams focused on active learning activities. This could involve group discussions, utilization of the flipped classroom model, integration of Think-Pair-Share activities, incorporation of argumentation exercises, or the inclusion of research paper discussions or discussions on the application of physics concepts.

d) Management of lecture hours to prioritize interaction and discussion, particularly emphasizing real-world scenarios to enhance contextual understanding.

e) Arrangement of industry visits such as Healthcare/Telecommunication/Defence and so on and so forth, for the first-year engineering students to provide practical exposure to physics-related concepts.

f) Adoption of a Heutagogy learning approach within the confines of the syllabus.

g) The Likert scale, commonly used for gauging opinions, faces limitations including response set bias and social desirability bias, influencing data accuracy. Contextual factors like question wording and sequence can introduce bias, affecting validity. Minimizing ambiguity in question-wording and utilizing alternative scale formats can mitigate these effects. Statistical tools can complement feedback surveys in supporting research objectives.

These factors will be duly considered in the forthcoming implementation of CTL in the Physics curriculum.

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