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The Success of Contextual Learning from Engineering Teacher Training Students' Learning Outcomes in Bangladesh

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Abstract— This study aims to evaluate the success of contextual learning implementation in engineering education in Bangladesh, identify the main challenges faced, and provide recommendations to improve the relevance and effectiveness of the method. The background of this study focuses on the importance of implementing learning that connects theory to practice, which can improve student engagement and educational relevance. The method used in this study is a qualitative approach with data analysis obtained through in-depth interviews with lecturers and students and observations of the implementation of contextual learning methods in several engineering educational institutions in Bangladesh. The study's findings indicate that contextual learning positively impacts students' understanding of the material and the development of practical skills. However, the main challenges are limited facilities, lack of lecturer training, and misalignment between the curriculum and the project-based approach. The implications of these findings indicate the need for improving educational infrastructure, more intensive training for lecturers, and aligning the curriculum with industry demands to improve the effectiveness of contextual learning. This study recommends strengthening collaboration between educational institutions and the industry sector to provide students with more relevant and applicable learning opportunities.

Keywords: Contextual learning, learning outcomes, teaching, techniques, higher education, educational strategies, educational evaluation.

I. INTRODUCTION

Contextual learning has long been recognized as an approach that can increase the relevance of education to the real needs of the workplace and life (Cropley & Knapper, 2021). In engineering education, this strategy helps students integrate academic knowledge with practical applications in their professional lives (Anyichie & Butler, 2020; Perry et al., 2020). This approach is especially relevant in today's world, where the workforce requires professionals with technical competence and critical thinking, communication, and collaboration skills (Rahman et al., 2020). In Bangladesh, engineering education faces significant challenges. Research reports indicate that curricula are often not aligned with industry needs, resulting in poor job readiness for graduates (Schmidt et al., 2018). In addition, lack of infrastructure, inadequate teacher training, and limited access to modern technology further exacerbate these challenges (Hennessy et al., 2022; Rahman et al., 2020). Therefore, innovative and relevant approaches, such as contextual learning, are needed to address this gap.

The contextual learning approach involves integrating real contexts into the learning process to make the material more relevant and meaningful to students (Moore et al., 2021). Research by Anyichie and Butler (2020) shows that this method effectively increases student motivation and deepens their understanding of concepts. In addition, Schmidt et al. (2018) highlighted that context-based approaches support the development of important skills such as problem-solving and innovation, which are highly needed in the global workplace.

Contextual learning is an innovative approach linking academic content to students' real-world experiences, providing practical relevance in everyday life and the workplace (Kim et al., 2019). This approach effectively increases student engagement and learning outcomes, particularly in engineering education (Anyichie & Butler, 2020; Santos et al., 2019). In engineering education in Bangladesh, significant challenges include the lack of relevance of the curriculum to global industry needs and limited resources and teacher training (Rahman et al., 2020).

Globally, engineering education is increasingly geared towards producing graduates with technical competence and critical thinking, collaboration, and adaptation skills to technological change (Kembuan et al., 2023; Perry et al., 2020; Schmidt et al., 2018).

In Bangladesh, despite government efforts to improve the education system, the implementation of context-based learning is still in its early stages of development.

Previous studies have highlighted the benefits of contextual learning, particularly in engineering education. Schmidt et al. (2018) showed that integrating real contexts in learning improves problem-solving skills and conceptual understanding. Anyichie and Butler (2020) suggested that strategies such as project-based learning enable students to develop interpersonal skills that are essential for the job market.

In the last decade, contextual learning has significantly focused on developing engineering education curricula. Schmidt et al. (2018) reported that developed countries have successfully integrated this method into their education systems, resulting in more competent and adaptive graduates. Perry et al. (2020) stated that implementing project-based learning as a contextual approach has successfully improved students' critical thinking and collaboration skills in various engineering fields.

However, the implementation of this strategy in developing countries still needs to be improved. Rahman et al. (2020) highlighted that most institutions in developing countries, including Bangladesh, still rely on traditional teacher-centered teaching methods. This results in low student engagement and a lack of relevance of learning to the real world. Thus, there is an urgent need to explore and adopt contextual learning approaches in these countries.

However, studies focusing on developing context-based curricula in developing countries such as Bangladesh still need to be completed. Most current studies focus on cognitive aspects without exploring how contextual learning can improve non-technical skills, such as leadership and communication (Rahman et al., 2020; Perry et al., 2020).

The need for more research on the impact of contextual learning in developing countries is a significant gap in the literature. Most studies focus on developed countries, with little attention to the challenges and potential of implementing this learning in developing country contexts such as Bangladesh (Schmidt et al., 2018).

Although much research has been conducted on the benefits of contextual learning, most of these studies focus on developed countries with good educational infrastructure (Anyichie & Butler, 2020; Perry et al., 2020). Research on applying this approach in developing countries, especially Bangladesh, still needs to be completed. In addition, most previous studies only highlight cognitive learning outcomes without exploring their impact on developing non-technical skills such as leadership, communication, and cultural adaptation (Rahman et al., 2020; Schmidt et al., 2018).

This study offers a novel contribution by evaluating contextual learning strategies in the context of engineering education in Bangladesh. This study integrates the evaluation of academic and non-academic outcomes, which include skills relevant to the needs of the 21st-century industry. This approach is expected to bridge the gap between the academic world and the needs of the global workforce (Rahman et al., 2020; Perry et al., 2020). This study not only evaluates students' learning outcomes from the cognitive aspect but also explores its impact on non-technical skills relevant to the world of work. In addition, this study also aims to identify the challenges faced in implementing this approach and provide practical recommendations to improve its effectiveness (Anyichie & Butler, 2020; Rahman et al., 2020).

Problem formulation:

1. How is the implementation of contextual learning strategies in engineering education programs in Bangladesh?
2. What are the main challenges faced in implementing contextual learning?
3. To what extent does contextual learning affect the learning outcomes of engineering students from the cognitive, affective, and psychomotor aspects?

This study aims to:

1. Evaluate the success of contextual learning implementation in engineering education in Bangladesh.
2. Identify the main challenges faced in implementing contextual learning strategies.
3. Develop recommendations to improve the relevance and effectiveness of contextual learning in engineering education.

This study is expected to significantly contribute to improving the quality of engineering education in Bangladesh. By integrating the contextual learning approach, the results of this study are expected to be a reference for policymakers, educators, and educational institutions in developing a more relevant and effective curriculum. In addition, the findings of this study are also expected to contribute to the academic literature on contextual learning in developing countries.

II. METHOD

This study used a quantitative and qualitative (mixed-methods) approach to evaluate the success of implementing contextual learning strategies in

engineering education in Bangladesh. This approach allows us to combine numerical data and descriptive perspectives, resulting in more comprehensive findings (Creswell & Plano Clark, 2018).

This study used a descriptive exploratory design. Descriptive research allows researchers to understand the phenomenon of contextual learning in depth through observations of implementing this strategy in a specific context (Yin, 2018). Meanwhile, the exploratory component focuses on identifying challenges and potential solutions to improve the implementation of contextual learning in engineering education environments (Creswell, 2014).

The study population included students, lecturers, and administrators from five engineering education institutions in Bangladesh that have implemented contextual learning in their curriculum. We took the sample using a purposive sampling technique, selecting students who have participated in contextual learning for at least one semester, lecturers involved in context-based teaching, and administrators responsible for curriculum policies. We chose this technique because it allows us to select participants relevant to the research objectives.

This study used several instruments to collect data:

1. Questionnaire: We used this instrument to collect quantitative data related to students' and lecturers' perceptions of the effectiveness of contextual learning. The questionnaire was designed based on a five-point Likert scale and covers the dimensions of learning motivation, student engagement, learning relevance, and learning outcomes.
2. In-depth Interviews: Semi-structured interviews were conducted with lecturers and administrators to understand the challenges in implementing this strategy and their perspectives on its impact on engineering education.
3. Classroom Observations: We conducted observations to record direct context-based teaching practices, including interactions between lecturers and students and project-based learning methods.

We carried out data collection in several stages:

1. Student and Lecturer Survey: The survey was conducted online, with 200 students and 50 lecturers responding.
2. In-depth Interviews: Based on their experiences implementing contextual learning, we selected 15 lecturers and five administrators for interviews.
3. Classroom Observations: The researcher conducted observations during ten context-based learning sessions at various institutions.

Data analysis:

1. Quantitative Analysis: The data obtained from the questionnaire were analyzed using descriptive and inferential statistics. This analysis included calculating the mean and standard deviation and testing the relationship between variables using regression analysis (Field, 2018).
2. Qualitative Analysis: Interview and observation data were analyzed using a thematic analysis approach, which involved identifying key themes emerging from the data (Braun & Clarke, 2006).

We ensured the instrument's validity through expert validation, where three experts in engineering education and contextual learning reviewed the questionnaire and interview guide. We tested the questionnaire's reliability using Cronbach's Alpha test, considering a value >0.7 as reliable (Taber, 2018).

This study adhered to the principles of research ethics, including informed consent, anonymity, and confidentiality of data. All participants were fully informed about the study's purpose and had the right to discontinue their participation at any time without consequence.

We conducted this study in five engineering educational institutions in Dhaka, Bangladesh, which have diverse applications of contextual learning. These sites were selected to gain diverse and representative insights into implementing this strategy.

The main limitations of this study include the limited time and resources required to collect data from all engineering education institutions in Bangladesh. Respondent bias is also a challenge, especially in online surveys that may not capture the views of all students.

With this methodological approach, we expect the study to provide a comprehensive picture of the effectiveness of contextual learning in engineering education in Bangladesh, as well as the challenges and opportunities for further development.

III. RESULTS

This study aims to evaluate the success of implementing contextual learning in engineering education in Bangladesh, identify key challenges in its implementation, and provide strategic recommendations to improve the relevance and effectiveness of this method. The following are the results obtained based on quantitative and qualitative analysis. From the data collected through the questionnaire, most respondents stated that implementing contextual learning positively impacts engagement and learning outcomes. The following

data (Table 1) summarizes the results from 200 students and 50 lecturers.

Table 1. Student and Lecturer Perceptions of the Implementation of Contextual Learning

Indicator	Average Student Score	Average Lecturer Score	Interpretation
Learning relevance	4.5	4.7	Very high
Student engagement	4.3	4.5	High
Understanding of technical concepts	4.2	4.4	High
Development of non-technical skills	4.1	4.3	High

The scores in the Table 1 indicate that contextual learning is considered relevant to students' needs and the workplace. An average score above 4.0 on a five-point Likert scale indicates the strategy's success in enhancing engagement and learning outcomes.

Observations of 10 project-based learning sessions showed that students actively participated in group discussions, developing innovative solutions and presenting their work. Lecturers acted as facilitators, encouraging students to apply the concepts they had learned in real-world situations.

Based on in-depth interviews with 15 lecturers and five administrators, the main challenges identified include (Table 2):

1. Infrastructure Limitations: Most institutions need more laboratory facilities and technology to support project-based learning. This affects the quality of contextual learning implementation.
2. Lack of Teacher Training: Some lecturers feel less confident in implementing this strategy because they lack formal training in contextual learning methods.
3. Curriculum Misalignment: A curriculum that is too dense with theory becomes an obstacle for context-based teaching, requiring more exploration time.

Table 2. Main Challenges Faced in Implementation

Challenge Category	Percentage of Respondents	Sample Respondent Comments
Infrastructure	70%	"We often lack the tools and space for large projects."
Teacher training	60%	"We need training to understand these strategies."
Curriculum	50%	"The curriculum is not flexible enough to support project-based learning."

During the observation, several technical constraints, such as lack of access to hardware and software, hampered the smooth learning process. In addition, several students appeared to need help collaborating due to limited previous experience in teamwork.

Based on the research results, several strategic recommendations are proposed (Table 3):

1. Infrastructure Improvement: The government and educational institutions need to allocate additional budgets to build laboratories equipped with modern technology to support the implementation of project-based learning.
2. Competency-Based Training for Lecturers: Regular training for lecturers in contextual learning methods will increase their capacity as facilitators.
3. Curriculum Flexibility: We must redesign the curriculum to provide space for project-based exploration. This includes reducing the portion of theory that needs to be more to industry needs.
4. Partnership with Industry: Educational institutions can collaborate with the industrial sector to provide accurate context for student projects through internship programs or research collaborations.

Table 3. Strategic Recommendations for Implementation Improvement

Recommend.	Description	Success Indicators
Infrastructure Improvement	Addition of laboratories and supporting technology.	Increased the number of laboratory facilities by 50%.
Lecturer Training	Competency-based training in contextual learning methods.	We have trained 70% of lecturers to use context-based methods.
Curriculum Revision	Adjustment of the curriculum to be more flexible to support project-based learning.	60% of the curriculum includes project-based activities.
Industry Partnerships	Collaboration with industry for student projects.	30% of students participate in internships or industrial projects.

A. Interpretation of Results

1. Implementation Success
   Contextual learning is efficacious in improving the motivation, engagement, and learning outcomes of engineering students in Bangladesh. However, its success rate varies depending on infrastructure support and lecturer skills.
2. Key Challenges
   The key barriers identified were limited infrastructure, teacher training, and curriculum mismatch. These challenges indicate the need for more attention from policymakers and educational institutions to support comprehensive implementation.
3. Strategic Recommendations
   The recommendations proposed can be a long-term solution to address the challenges faced. With the implementation of these strategies, engineering educational institutions in Bangladesh are expected to produce graduates who are better prepared for the world of work.

The results of this study provide valuable insights for improving the quality of engineering education in Bangladesh through the effective implementation of contextual learning. The findings are also relevant to institutions in other developing countries facing similar challenges.

B. Analysis of Research Findings

This study highlights the successes, challenges, and recommendations for improving contextual learning implementation in Bangladesh's engineering education. The research findings were analyzed by reviewing the findings from the perspective of educational theory, practical implications, and strategic potential for educational policy development. The following is an in-depth analysis of the results of this study:

The results show that contextual learning successfully increases student engagement and understanding in the context of engineering education. The high average scores on the learning relevance indicator (4.5 for students and 4.7 for lecturers) indicate that this strategy successfully bridges the gap between theory and practical application.

In educational theory, this success aligns with the principle of constructivism, which emphasizes the importance of relevant learning experiences to help students construct their knowledge. Contextual learning allows students to understand concepts through real-world applications, increasing retention and mastery of both technical and non-technical skills.

However, this success is challenging. We observed that more actively involved students tend to come from groups with better access to resources, highlighting a disparity we need to address. In addition, the level of success also depends on lecturers' ability to facilitate the project-based learning process.

Infrastructure limitations are the main obstacle to implementing contextual learning. As many as 70% of respondents identified inadequate laboratories and technological access as significant barriers. These shortcomings affect the effectiveness of project-based learning, especially in engineering fields that require specialized equipment and technology.

These infrastructure limitations also reflect the gap in funding for engineering education in developing countries. Previous studies have shown that investment in educational infrastructure is critical to supporting innovative learning strategies. A more significant budget allocation is needed to procure relevant educational tools to improve success.

Another significant challenge is the need for lecturers to receive more training. As many as 60% of lecturers admitted needing more formal training to understand contextual learning methods. This indicates the need for training programs that focus on developing lecturers' competencies in designing and implementing context-based learning.

The theory of professional development in education emphasizes that ongoing training is important to increase teachers' capacity to adopt innovative teaching methods. Adequate training can improve the effectiveness of contextual learning implementation.

Another significant barrier is the mismatch between existing curricula and project-based learning needs. Overly theoretical and dense curricula need to be redesigned to provide greater flexibility for context-based exploration. As many as 50% of respondents identified this as a significant obstacle.

Other studies also emphasize revising the curriculum to support project-based and contextual learning. Curriculum flexibility allows students to explore practical applications of the concepts learned, ultimately increasing the competitiveness of graduates.

Recommendations for improving infrastructure include investing in laboratories equipped with modern technology. This step highlights that adequate educational infrastructure is key to preparing graduates for work in the era of Industry 4.0.

However, implementing this recommendation is challenging due to the large funding requirement. Therefore, collaboration between the government,

educational institutions, and the private sector is needed to fund the procurement of the necessary facilities.

Regular training for lecturers is a top priority. This training should include:

1. Application of Contextual Learning Methods: Providing practical guidance for designing and implementing context-based projects.
2. Development of Technical Competence: Providing an understanding of the latest technologies relevant to engineering education.

This training not only builds lecturers' capacity but also creates a learning community where lecturers can share their best practices. Studies have shown that professional learning communities contribute to improved teaching quality.

Curriculum revision to increase flexibility is also important. A more contextual curriculum could include:

1. Reduction of irrelevant theoretical courses.
2. Addition of project-based modules.
3. Integration of cross-disciplinary learning.

These efforts will ensure that the curriculum is aligned with industry needs, increasing the relevance of graduates in the job market.

Partnerships with the industry sector allow students to work on real projects relevant to the workforce's needs. This collaboration can include internship programs, collaborative projects, and industry visits. Previous studies have shown that hands-on experience in industry improves students' understanding of workplace challenges and builds needed skills.

C. Implications of Research Findings

The results of this study serve as a guide for engineering education institutions to identify and address the challenges associated with effectively implementing contextual learning. The proposed strategies can be adopted in a phased manner to ensure the sustainability of implementation.

From a policy perspective, this study highlights the importance of long-term investment in engineering education. The government must prioritize infrastructure development, teacher training, and curriculum revision to support innovative learning methods.

The findings reinforce the theory of context-based education and project-based learning as practical approaches to enhance the relevance of engineering education. This study also adds to the literature on the challenges and opportunities in implementing these strategies in developing countries.

The analysis suggests that contextual learning has great potential to improve the quality of engineering education in Bangladesh. However, its success depends on adequate support from infrastructure, teacher training, and a flexible curriculum. By addressing the challenges through the recommended strategies, contextual learning can effectively prepare competent and workforce-relevant engineering graduates.

IV. DISCUSSIONS

This study explores the successes, challenges, and recommendations for implementing contextual learning in engineering education in Bangladesh. The results and analysis indicate that contextual learning has great potential to improve the relevance and effectiveness of engineering education, but several barriers require special attention. This section discusses the study's results in depth by linking the findings with references from previous studies and relevant theories.

The results showed that contextual learning increased student engagement in the learning process, with a high average score on learning relevance (4.5 for students and 4.7 for lecturers). This finding supports the constructivism theory, which states that learning experiences relevant to everyday life help students understand concepts better (Vygotsky, 1978).

Previous studies have also found that contextual learning can improve student motivation and learning outcomes. For example, a study by Kim et al. (2020) stated that project-based learning allows students to connect theory with practical applications, improving their understanding. Similarly, a study by Zohar and Barzilai (2021) showed that context-based learning encourages the development of critical thinking skills.

In addition to enhancing technical understanding, contextual learning contributes to developing non-technical skills such as communication, teamwork, and leadership. This aligns with the findings of Su et al. (2022), who showed that project-based learning helps students develop collaborative skills essential for professional success.

However, this success is uneven across institutions. Some students in institutions with limited facilities need help to engage in context-based projects fully. This suggests the need for improved infrastructure and training to support wider implementation.

Infrastructure limitations are a major barrier to contextual learning in Bangladesh. As many as 70% of respondents in this study stated that the lack of adequate laboratories and equipment hinders the implementation of context-based projects. This finding is consistent with the World Economic Forum

report (2022), which emphasizes that engineering education requires significant investment in facilities to support project-based leaming.

Research by Alam et al. (2021) in other developing countries also shows that lack of infrastructure is often a significant barrier to educational innovation. Therefore, governments and educational institutions must work together to address this issue through increased funding and collaboration with the industry sector.

As many as 60% of lecturers in this study felt less confident implementing contextual learning due to a lack of training. Lack of teacher training is a common challenge in many developing countries. Darling-Hammond et al. (2020) stated that ongoing professional training is essential to help teachers adopt innovative teaching methods.

To address this challenge, engineering education institutions in Bangladesh need to develop training programs that focus on project-based learning methods and the use of technology. Research by Mishra and Koehler (2021) suggests that technology-based training can help teachers feel more comfortable with new approaches.

Another significant barrier is the mismatch of the curriculum with the needs of project-based learning. As many as 50% of respondents in this study identified that the curriculum needed to be more theoretical and dense and provide more space for context-based exploration. Research by Rajaraman et al. (2020) also found that rigid curricula often hinder innovation in teaching.

Curriculum revision is needed to increase engineering education's flexibility and relevance. This could include adding project-based modules, reducing irrelevant theory, and integrating cross-disciplinary learning.

Improving the infrastructure of engineering education is essential to support contextual learning. The Bangladesh government must allocate an additional budget to build modern laboratories and provide access to the latest technology. Research by UNESCO (2021) shows that educational infrastructure investment contributes significantly to education quality.

Competency-based training programs can help teachers develop the skills to implement contextual learning. This training should include context-based project design, use of technology, and collaborative classroom management. Darling-Hammond et al. (2020) stated that training that focuses on developing practical skills is more effective in improving teacher capacity.

The curriculum should be revised to provide greater flexibility in supporting project-based learning. This step is in line with recommendations from the Partnership for 21st Century Skills (2021), which emphasizes the importance of curriculum flexibility in preparing students for the challenges of the 21st century.

Partnerships with the industry sector can provide real-world context for student projects. For example, internships or collaborative projects with engineering companies can help students understand workplace needs. Research by Tymon (2019) shows that hands-on experience in industry improves students' technical and non-technical skills.

The results of this study suggest that contextual learning can improve the quality of engineering education in Bangladesh, but its success depends on strong policy support. The government must adopt a long-term approach to address infrastructure challenges, teacher training, and curriculum revision.

The results of this study provide guidance for educational institutions to improve the implementation of contextual learning. Improving infrastructure, training faculty, and collaborating with industry can help overcome the barriers.

From a theoretical perspective, this study supports constructivism and project-based learning as effective approaches in engineering education. It also expands the literature on the challenges and opportunities in implementing these methods in developing countries.

This discussion confirms that contextual learning has great potential to improve the quality of engineering education in Bangladesh. However, to achieve optimal results, a collaborative effort between the government, educational institutions, and the industry sector to address the existing challenges is needed. These findings are relevant not only to Bangladesh but also to other developing countries facing similar challenges in engineering education.

V. CONCLUSION

Based on the research results, this study has proven that contextual learning increases student engagement, enhances understanding of the material, and develops non-technical skills such as critical thinking and collaboration. However, several challenges, such as limited infrastructure, lack of training for lecturers, and misalignment of the curriculum with the project-based approach, still need to improve effective implementation.

Several key factors support the success of contextual learning, including the availability of adequate facilities, ongoing training programs for lecturers, and a more flexible curriculum that integrates project-based learning. Although this approach has great potential, the success of its

implementation is highly dependent on support from various parties, be it the government, educational institutions, or the industrial sector.

The main recommendations for increasing the effectiveness of contextual learning are to strengthen educational infrastructure, provide better training for lecturers, and update the curriculum to be more relevant to the needs of the industrial world. In addition, closer collaboration between educational institutions and the industrial sector is needed to create real-world learning opportunities for students.

Overall, although contextual learning has great potential, the challenges that exist require coordinated efforts between various parties to ensure the success and relevance of this method in engineering education in Bangladesh or low-income developing countries.

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