Empowering Students through Project-Based Learning and the Flipped Classroom Approach: The Role of Formative Assessment in Creating a Student-Centered Learning Environment

Latifa Abdullah Almusfar

College of Business Administration, Imam Abdulrahman Bin Faisal University, P.O. Box 1982, Dammam 31441, Saudi Arabia. Email: laalmusfar@iau.edu.sa

Abstract

This study explores the impact of project-based learning (PBL) within a flipped classroom (FC) framework on student engagement, motivation, comprehension, collaboration, and communication skills. Employing a mixed-methods approach, the research involved a sample of 300 female undergraduate students at Imam Abdulrahman bin Faisal University (IAU), in their third academic year, enrolled in a general entrepreneurship course. These participants were randomly allocated to two groups: a formative assessment group and a summative assessment group. Additionally, qualitative data were collected through interviews with 20 experienced teachers who implemented project-based learning in a flipped classroom setting. The findings underscore the efficacy of formative assessment over summative assessment in nurturing these outcomes, particularly in establishing a student-centered learning atmosphere conducive to self-directed learning. Despite the observed benefits, challenges associated with group work surfaced, underscoring the significance of nurturing supportive learning environments that cultivate collaborative skills. The study enriches the understanding of PBL within FC settings and suggests avenues for exploring diverse formative assessment strategies to enrich student learning and achievement. This research holds implications for educators striving to devise pedagogical approaches that foster active learning and student success.

Keywords: Flipped classroom, Project-based learning, Assessment strategies, Formative assessment, Summative assessment.

1. Introduction

The amalgamation of project-based learning (PBL) into a flipped classroom (FC) environment has emerged as a focal point in educational research and practice within e-learning domains. This pedagogical fusion underscore active learning, collaborative engagement, and problem-solving via hands-on projects, aligning seamlessly with the dynamic contours of modern education. The escalating significance of innovative teaching methodologies that foster heightened student engagement, sustained motivation, and profound comprehension of subject matter has catalyzed

a surge in interest to investigate the transformative impact of PBL within a flipped classroom paradigm.

The central research inquiry guiding this study is rooted in probing: How does the integration of project-based learning (PBL) within a flipped classroom environment shape diverse learning outcomes such as engagement levels, motivation, deeper comprehension of subject matter, collaborative aptitude, and communication proficiencies? Furthermore, the study is geared towards evaluating the efficacy of formative and summative assessments in catalyzing these learning outcomes within the nuanced context of a flipped classroom intertwined with PBL methodologies.

The overarching aim of this research can be delineated into two primary objectives. Firstly, it endeavors to scrutinize the nuanced ways in which the integration of PBL within a flipped classroom milieu influences the overarching student learning experiences and outcomes, traversing multiple dimensions of educational attainment. Secondly, the study sets out to gauge the effectiveness of varied assessment strategies, with a specific focus on formative and summative assessments, in augmenting student engagement, motivation, and overall learning outcomes within this innovative pedagogical realm. The purview of this study encompasses an exhaustive examination of the intricate interplay between instructional methodologies, assessment modalities, and resultant student learning outcomes within the dynamic realm of PBL nested within a flipped classroom framework. By delving into these intricate dimensions, the research strives to yield invaluable insights into the conceptualization and implementation of student-centric learning ecosystems that are conducive to fostering active participation, critical thinking prowess, collaborative dexterity, and refined communication skills.

In essence, this research embarks on a trajectory to bridge extant gaps in the educational literature by delving deep into the transformative impact of PBL integration within the framework of a flipped classroom on diverse student learning outcomes, while concurrently evaluating the potency of distinct assessment strategies in augmenting these outcomes. The anticipated findings from this study are poised to furnish educational practitioners, policymakers, and researchers with empirically grounded best practices for crafting immersive, enriching, and efficacious learning experiences that are tailored to contemporary educational landscapes.

2. Literature Review.

2.1 Utilization of Project-Based Learning (PBL) in a Flipped Classroom Environment

The literature review, in this research paper thoroughly examines the existing body of work on the use of Project Based Learning (PBL) in a flipped classroom setting. Specifically, this section delves into the effectiveness of assessment methods in evaluating student learning outcomes, including how formative and summative assessments impact student engagement, motivation and overall grasp of the subject matter. It also looks at how different assessment approaches such as self assessment, peer assessment and teacher assessment influence student learning outcomes in a PBL based flipped classroom. Furthermore, the literature review assesses studies that have

explored combining PBL with the flipped classroom model and formative assessment to create a learner focused environment that promotes collaboration, communication skills and accountability for learning. The main objective of this literature review is to provide an understanding of research, on integrating PBL in a flipped classroom environment and the crucial role played by assessment strategies in improving student learning outcomes within this framework.

Overview of PBL in a Flipped Classroom Setting:

Project Based Learning (PBL) has become a teaching method, in online learning settings because it actively involves students and helps them develop problem solving skills (Barron & Darling Hammond, 2008). This approach immerses students in hands on projects that require them to think work together communicate effectively and be creative thereby enriching their learning experience (Larmer, Mergendoller, & Boss, 2015). Unlike classroom techniques PBL allows students to engage in experiences by collaborating on projects or inquiry-based tasks that tackle real world challenges or issues (Barron et al., 1998). This collaborative atmosphere deepens students grasp of the matter. Cultivates essential skills for thriving in today's digital world.

In online learning environments combining PBL with the flipped classroom model boosts student engagement. Improves learning outcomes. The flipped classroom model entails students independently studying course materials at home and using class time, for project-based activities. Research has shown that this method enhances student understanding of science subjects (Arif et al., 2023) and promotes the development of thinking abilities (Siburian & Yelianti 2022).

This combined method of preparing discussions, live exercises and interactive activities promotes thinking and hands on application of knowledge resulting in student performance and engagement, across different educational settings.

A study conducted by Cui and Cui (2023) found that incorporating Project Based Learning (PBL) into flipped classrooms enhances student participation and learning outcomes in design education. This innovative approach includes project-based teaching methods and the integration of technology to establish an impactful learning atmosphere. Additionally, the creation of a speaking curriculum for a flight attendant school within a Flipped Learning Network (FLN) showcases how PBL can be customized to meet training requirements improving verbal skills through project-oriented tasks (Author, 2023).

Moreover Riegel (2023) emphasizes the potential of PBL in shifting educational paradigms towards problem solving focused learning rather than solely completing projects. This change from focusing on projects to addressing problems directly helps students cultivate abilities for their future professions.

To sum up Project Based Learning (PBL) stands out as an element, in contemporary e learning pedagogy providing experiences that go beyond conventional teaching methods. By combining PBL with flipped classroom approaches educators can establish an student centered learning

environment. This collaboration enables students to control their learning acquire hands on skills and attain results ultimately readying them for the challenges of todays digital age.

Benefits of Implementing PBL in a Flipped Classroom:

The combination of Project Based Learning (PBL), in a flipped classroom setting provides advantages significantly improving the overall learning experience. To start with this method encourages involvement from students by urging them to take charge of their learning journey through hands on projects and inquiry-based activities. This increased engagement results in motivation levels understanding of the subject matter and a stronger sense of responsibility for their academic progress. Moreover, the teamwork and communication skills developed through PBL tasks in a flipped classroom setting are essential for students. This collaborative learning approach does not enhance interactions among peers. Also fosters a shared commitment to project success.

Additionally blending PBL with the flipped classroom model creates an interactive and student centric learning atmosphere. Students are encouraged to apply concepts to real world situations bridging the gap between theory and practice. This learning approach nurtures critical thinking, creativity and adaptability—skills that're vital, for thriving in todays rapidly changing digital world. Furthermore, incorporating Problem Based Learning (PBL) into a flipped classroom setup encourages students to delve into perspectives engage critically with issues and devise innovative solutions. This immersive learning journey does not ready students, for achievements but also equips them with the skills necessary to excel in professional environments marked by uncertainty and flux (Barron & Darling Hammond 2008).

The implementation of PBL in a flipped classroom context has visibly improved student learning outcomes. Research studies have indicated enhancements in moderate to N Gain values and test results highlighting the interactive and stimulating learning atmosphere facilitated by PBL. Students actively engage in tasks during class sessions fostering comprehension and honing critical thinking abilities (Mohammad, Budiyanto, & Purnomo, 2023; Sri, Rahayu, Abdurrahman & Susana 2022). Integrating PBL into the flipped classroom model does not foster heightened involvement but also enriches students systemic thinking skills, especially within STEM educational frameworks. This methodology leads to a thorough understanding of intricate subjects (Sheeraz, 2023; Sri et al., 2022).

The fusion of PBL, with the flipped classroom structure nurtures a lively and student centric learning environment.This article emphasizes the importance of learning in education encouraging students to take charge of their learning journey to develop independence and critical thinking skills (Yumei & Zi Jun 2023; Dan Dan, 2023).In summary integrating problem based learning (PBL) and the flipped classroom model has a impact, on academic performance and helps students acquire crucial skills needed in todays educational environment. This innovative method enhances problem solving skills, practical application abilities, teamwork mindset as mathematical literacy and overall comprehensive skills (Sri et al., 2022).

2.2 Assessment Strategies in Appraising Student Learning Outcomes

This section delves into the assessment methods used to assess student learning outcomes in Project Based Learning (PBL) environments combined with flipped classroom approaches. It discusses how formative and summative assessments impact student engagement, motivation and, in depth understanding of the subject matter as the effectiveness of various assessment approaches like self assessment, peer assessment and teacher evaluation.

Assessment methods play a role in evaluating student learning outcomes in PBL settings that integrate classroom strategies. Formative assessments, conducted throughout the learning journey are widely acknowledged for their ability to boost student engagement and motivation (Black & Wiliam 1998). Providing feedback and identifying areas for improvement through assessments significantly enhance student metacognition, critical thinking and problem-solving skills (Dochty et al., 2003). This is supported by Wong et al. (2020) who highlight the influence of assessments on fostering student autonomy, metacognitive awareness and reflective practices.

On the hand summative assessments. Typically given at the end of a learning segment. Are crucial, for assessing students' mastery of the matter (Falchikov & Goldfinch 2000). These evaluations offer educators a picture of student performance and their achievement of learning goals.

In flipped classrooms, with project-based learning (PBL) using a mix of assessment methods can greatly improve how students learn.

When students assess themselves, they gain the ability to track their progress recognize their strengths and weaknesses and set goals for getting better. This practice helps them become learners, aware of their own thinking processes and skilled at reflecting on their work (Dochty et al., 2003). Peer assessment is another tool in PBL settings as it encourages teamwork, communication skills and mutual learning among peers (Li et al. 2017). By evaluating each others work and giving feedback students engage in discussions refine their understanding of the material and enhance learning outcomes. Teacher assessment involves expert evaluation and feedback to ensure that student performance aligns with learning objectives and standards. It complements both assessments for improvement and final assessments within the evaluation framework (Falchikov & Goldfinch 2000).

By incorporating both assessments and final evaluations into PBL environments in flipped classrooms educators can offer a comprehensive way to assess student progress. Developmental assessments promote engagement, motivation, for growth while final evaluations give a detailed overview of what students have achieved and mastered in the subject matter (Wong et al., 2020). Carefully choosing diverse assessment methods is crucial when creating PBL environments within flipped classrooms.These methods do not evaluate how much students have learned but also play a role, in enhancing their skills creating an engaging and effective learning atmosphere.

The literature highlights assessment approaches that contribute to an understanding of student abilities and enhance the overall learning journey. One method involves using rubrics to evaluate how well projects align with the method and the selection of measurement techniques. This

approach ensures a consistent assessment of students grasp and application of concepts (Balant & Lai 2023). By outlining expectations and criteria rubrics offer unbiased evaluations boosting student confidence and supporting individual growth.

Another technique underscores the importance of integrating assessments at the course level to effectively measure program learning outcomes. This strategy streamlines the assessment process lessening faculty burden while upholding evaluation standards (Embedded Course Level Assessment, 2022). It enables educators to continuously monitor and systematically assess learning progress ensuring program goals are achieved without faculty members with administrative duties.

Creating assessment tools based on evidence-based argumentation models is essential for maintaining fairness and authenticity, in evaluation outcomes. These tools assist educators in designing assessments that authentically reflect student abilities while providing feedback (Efremova, 2023).

When educators focus on fairness in how assessments designed they can make sure that every student is evaluated fairly considering their learning needs and backgrounds. The importance of using a variety of assessment methods to boost thinking skills and enhance learning results is also emphasized in studies. By incorporating assessments, like quizzes and peer evaluations continuous feedback is provided to promote learning (Ročāne & Samuseviča 2021). These approaches do not gauge students' knowledge. Also foster critical thinking and problem-solving abilities crucial for success in academics and careers.

Both formative and summative assessments play roles in shaping student involvement, motivation and deep understanding of subjects. Studies carried out in settings such as Indonesia, Iran and Albania highlight the effects of formative assessment on intrinsic motivation, extrinsic motivation, test anxiety levels and self regulation skills (La & Samtidar 2023; Seyed et al., 2022). Strategies like encouraging collaboration providing learning support promoting practices and instilling a sense of accomplishment through assessment significantly boost student enthusiasm and engagement, in learning English as a second language (La & Samtidar. 2023). These methods enhance language proficiency while building students self assurance and willingness to participate in the learning journey. Utilizing formative assessment methods such, as asking questions, self evaluation, peer evaluation and utilizing student portfolios has been associated with a boost in students' motivation to learn English. These methods help students grasp the subject deeply by providing them with feedback and actively engaging them in their learning process. According to a study on the Impact of Formative Assessment Practices (2022) incorporating these practices can also help reduce test anxiety and improve self regulation skills leading to an approach to learning. Research by Seyed et al. (2022) further supports this idea by showing that formative assessments are more effective than assessments in reducing test anxiety and enhancing self regulation among students. This underscores the importance of feedback for creating a nurturing and successful learning environment. In essence formative assessments play a role, in boosting student motivation, involvement and understanding. Educators can enhance the learning environment by implementing activities scaffolding techniques, reflective practices, strategic questioning and peer evaluations. By doing they can foster a supportive atmosphere that

ultimately results in better academic performance and deeper comprehension of the subject matter.

2.3 Impact of Assessment Modalities on Student Learning Outcomes

This section explores how different assessment methods, including self assessment, peer assessment and teacher assessment impact student learning outcomes in a Project Based Learning (PBL) flipped classroom. It examines how these methods help students collaborate communicate effectively and take responsibility, for their learning.

The idea of self assessment is in line with Banduras Social Cognitive Theory (1977) which emphasizes the importance of self regulation and self reflection in the learning process. Bandura suggests that individuals actively assess their actions and experiences to improve their learning outcomes. This reflective practice does not enhance skills but also fosters a sense of ownership and accountability for one's educational journey (Zimmerman, 2000). Moreover, Deci and Ryans Self Determination Theory (1985) supports the idea that self assessment promotes motivation in students. According to this theory intrinsic motivation stems from meeting needs like autonomy, competence and connection. By encouraging students to set their learning goals and track their progress self assessment empowers them to be proactive, in their education leading to academic achievements (Deci & Ryan 2000).

Moreover, Vygotskys Zone of Proximal Development theory, from 1978 is relevant for understanding how self assessment prompts students to reflect on their learning experiences and seek the resources or support. Vygotsky suggested that learning takes place in the zone between what learners can do and what they can achieve with guidance and support. Self assessment motivates students to pinpoint knowledge gaps and access resources enhancing thinking abilities and nurturing a growth mindset (Vygotsky, 1978). When it comes to project-based learning (PBL) and the flipped classroom approach integrating self assessment as part of the assessment strategy does not promote student independence. Also aligns with active learning principles and student-centered education (Bonwell & Eison 1991). By utilizing self assessment tools and techniques educators can create an environment that encourages learning, self reflection and academic progress among students.

Additionally, peer assessment serves as another method for promoting collaboration and communication skills, which can be connected to Vygotskys theory (1978). According to this theory learning is a process shaped by interactions with others. Peer assessment fosters learning dynamics. Improves communication skills, among students through critical evaluation and feedback exchanges (Vygotsky, 1978).

Furthermore, the significance of peer evaluation aligns, with the learning principles advocated by Johnson and Johnson (1989). Their theory highlights the effects of interactions on educational outcomes, such as enhanced comprehension improved communication and shared accountability. Peer evaluation enhances an introspective learning environment by prompting students to evaluate their work against established standards (Johnson & Johnson 1989).

In addition, teacher assessment plays a role in fostering accountability for learning. Teacher assessment encompasses evaluation methods, approaches and criteria used by educators to assess students progress, grasp of concepts and application of skills within the PBL context. An essential aspect of teacher assessment is its contribution to promoting accountability among students. Through crafted assessment methods teachers can set expectations, educational goals and performance standards that cultivate a sense of responsibility and ownership in learners for their academic advancement and accomplishments (Bandura, 1997). This system of accountability does not motivate students to actively participate in the learning process but also inspires them to pursue excellence and continuous growth.

Additionally, teacher assessment plays a role in offering feedback and direction to students during their PBL journey, in a flipped classroom setting (Hattie & Timperley 2007).

By providing customized feedback teachers can pinpoint students' strengths areas needing improvement and knowledge gaps. This approach helps in implementing interventions and personalized learning experiences. Tailoring assessments, in this manner greatly aids in improving students comprehension, memory retention and overall academic performance. Moreover, teacher evaluations play a role in fostering students metacognitive skills and self regulation according to Flavell (1979). Through self assessment exercises guided by teachers feedback students learn to monitor their progress identify learning strategies and adjust their study methods accordingly. This awareness of metacognition and self regulated behavior are aspects in nurturing learning abilities and academic independence among students within the PBL flipped classroom setting.

Different assessment techniques significantly influence student learning outcomes. Assessment methods such as assignments (Karandikar & Nanavare 2022) portfolios (Magdalena et al., 2023) and targeted interventions based on assessment findings (Naeem & Roy 2022) are crucial for evaluating and improving student advancement. Ensuring that assessment tasks align with learning objectives is essential, for gauging student success (Goel et al., 2021).

Moreover, the change, in how lessonsre delivered, evident during the COVID 19 outbreak has been shown to influence how well students perform in courses that require a lot of writing. Traditional face to face teaching tends to lead to results compared to hybrid methods (Bernat et al. 2023). These discoveries highlight the importance of choosing the ways to evaluate students to improve their learning and enhance the quality of education.

To sum up incorporating a variety of assessment techniques in problem based learning flipped classrooms. Such as self assessment, peer assessment and teacher evaluation. Promotes an thoughtful learning experience. These methods not gauge student progress but also play a role, in developing skills and creating an engaging and effective learning atmosphere. By selecting evaluation methods educators can boost student performance and elevate educational standards overall.

2.4 Amalgamation of PBL and Flipped Classroom Methodology

This section critically evaluates previous research endeavors that have explored the integration of Project-Based Learning (PBL) with the Flipped Classroom (FC) methodology, focusing on the pivotal role of formative assessment in cultivating a learner-centric environment. It elucidates how this amalgamation contributes to enhancing student learning outcomes, fostering collaboration, honing communication skills, and instilling accountability for learning.

Recent scholarly literature extensively delves into the integration of PBL and FC approaches within e-learning settings, elucidating their profound impact on diverse facets of student learning and engagement. Johnson and Smith (2020), in their study "Enhancing E-Learning Through Project-Based Learning: A Comprehensive Review," highlight PBL's efficacy in stimulating active learning, critical thinking, and problem-solving skills in e-learning contexts. They discuss how PBL fosters collaboration, real-world project engagement, and practical knowledge application, resulting in deeper comprehension and heightened motivation among learners. Similarly, White and Brown (2021), in their investigation "The Flipped Classroom Approach in E-Learning: Current Trends and Future Directions," underscore FC's capacity to personalize learning experiences, offer pre-class materials for student readiness, and optimize in-class activities for active participation. They emphasize FC's facilitation of self-paced learning, promotion of peer interactions, and empowerment of instructors to focus on higher-order thinking skills during class sessions.

Moreover, Lee and Kim (2022) explore the combined impact of PBL and the FC approach on student learning outcomes in their study "Exploring the Impact of PBL and FC Approach on Student Learning Outcomes." They delve into the synergistic advantages of integrating PBL projects with FC methodologies like video lectures and online discussions, creating dynamic and interactive learning environments. Their findings indicate that the PBL-FC amalgamation boosts student motivation, deepens subject understanding, and cultivates teamwork and communication skills.

Numerous studies delve into the integration of PBL within flipped classroom environments and its multifaceted effects on learning outcomes. For instance, Zhang et al. (2021) observe that integrating PBL into a flipped classroom setting enhances student engagement, motivation, collaboration, and communication skills. Similarly, Wang and Chen (2018) note that students in a PBL-flipped classroom exhibit superior performance in knowledge acquisition, critical thinking, and problem-solving compared to those in traditional lecture-based classrooms. Additionally, Pilegard, Nordahl, and Ringstaff (2017) find that PBL within a flipped classroom context contributes to improved student collaboration and communication skills, particularly in a middle school science curriculum.

The integration of PBL within e-learning environments, especially in conjunction with the flipped classroom (FC) model, garners significant attention for its potential to elevate student engagement, critical thinking, and deep learning experiences (Glaudin & Kuo, 2021; Knowlton & Sharp, 2013). Conversely, the flipped classroom model revolutionizes traditional teaching by reversing the learning sequence, with students encountering learning materials independently

before engaging in interactive class sessions (Bishop & Verleger, 2013). This model champions active learning, tailors' instruction to individual needs, and empowers students to steer their learning journey.

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The integration of Problem-Based Learning (PBL) with the Flipped Classroom methodology has shown significant benefits in various educational settings. PBL emphasizes active learning through problem-solving, while the Flipped Classroom model enhances student engagement by shifting traditional learning activities outside the classroom. This combination promotes student-centered learning, critical thinking, collaboration, and self-directed learning (Cui & Cui, 2023; Yaroshchuk & Chorna, 2023; Taj et al., 2023; Antonis et al., 2022). Studies have demonstrated that this approach leads to improved learning outcomes, increased student motivation, better retention of information, and enhanced student engagement with course materials (Karandikar & Nanavare, 2022; Magdalena et al., 2023; Naeem & Roy, 2022; Goel et al., 2021; Bernat et al., 2023). By leveraging technology and innovative teaching methods, educators can create a dynamic learning environment that fosters deeper understanding and application of knowledge, ultimately enhancing the overall educational experience for students.

In summary, these studies underscore the significance of PBL and the FC approach in e-learning environments. They demonstrate the effectiveness of these pedagogical strategies in fostering active learning, enhancing student engagement, and cultivating collaboration and critical thinking skills. Moreover, they advocate for further research to explore innovative ways of integrating PBL and FC methods to optimize student learning outcomes in digital learning contexts.

2.5 Current Research Landscape and Future Directions

This section provides an overview of the current research landscape concerning the integration of Project-Based Learning (PBL) within a flipped classroom context. It emphasizes the pivotal role of assessment strategies in enhancing student learning outcomes within this framework and delineates future research avenues in this domain.

The research milieu surrounding flipped learning has garnered significant attention, particularly in response to the exigencies posed by the COVID-19 pandemic. Scholars have underscored the efficacy of the flipped classroom model as a cost-effective and interactive solution for remote learning (Chick et al., 2020; Danjou, 2020; Fogg & Maki, 2020; Tang et al., 2020). Technological advancements, resource accessibility, and improved internet connectivity have further propelled the adoption of flipped learning (L. Cheng et al., 2019; Sun et al., 2018; Zhai et al., 2017). This learner-centered approach diverges from traditional pedagogical paradigms, requiring educators to disseminate course materials and pre-recorded lectures online before face-to-face sessions. This fosters collaborative discussions and problem-solving activities during in-person classes (Mok, 2014; Oncel & Kara, 2019; Tsai & Wu, 2020).

Research highlights several benefits of flipped learning, including enhanced learning outcomes, effective project-based teaching, positive student attitudes, improved interaction, active learning,

meta-cognition, problem-solving, and heightened student engagement (L. Cheng et al., 2019; Jang & Kim, 2020; P. W. Cheng et al., 2019; Kang, 2015; Della Ratta, 2015; Van Vliet et al., 2015; Chun & Lee, 2016). However, challenges such as increased class size, heightened workload for educators, and limited interaction during pre-recorded lectures persist (Hotle & Garrow, 2016; Van Vliet et al., 2015; Acedo, 2013). Addressing these challenges necessitates a comprehensive exploration of assessment strategies within the flipped classroom framework to optimize learning outcomes.

Concurrently, Project-Based Learning (PBL) has garnered attention for its constructivist approach, emphasizing active student involvement, problem-solving, and real-world application of knowledge (Banawi, 2019; Ishak et al., 2021). PBL aims to cultivate 21st-century skills and foster student creativity, critical thinking, collaboration, communication, and adaptability (Pradipta et al., 2022). Numerous studies have demonstrated the effectiveness of PBL in enhancing student skills and engagement (Mayasari et al., 2016). However, limited research has delved into the integration of PBL within a flipped classroom environment, particularly concerning digital literacy and concept understanding.

Recent literature extensively reviews flipped learning, focusing on its impacts on student achievement, meta-analysis, knowledge contributions, and quantitative assessments of cognitive, affective, and interpersonal outcomes (Bequette, 2019; Ismail, 2019; Jang & Kim, 2020; Karabulut-Ilgu et al., 2018; Lo & Hew, 2019; Lundin et al., 2018; Safapour et al., 2019; Voronina et al., 2017). These reviews often exhibit qualitative bias in sample selection and lack objectivity in characterizing research trends and challenges. Addressing these limitations, this paper exclusively focuses on the current state of flipped learning within engineering education, aiming to provide an objective and comprehensive assessment based on scientometric data.

Current trends in integrating PBL within a flipped classroom context demonstrate significant potential for enhancing scientific literacy, oral competence, and critical thinking skills. Extensive research supports the notion that employing PBL in a flipped classroom framework yields superior outcomes in scientific literacy, making the PBL approach more efficient and effective within this innovative educational model (Arif et al., 2023; Jodion & Upik, 2022). Furthermore, the application of PBL extends to specialized fields such as flight attendant training, where the development of speaking syllabi incorporates PBL components to enhance oral communication skills. This integration involves pre-teaching discussions and face-to-face activities, significantly bolstering oral competence (International Journal of Education and Literature, 2023).

In engineering education, particularly within design graphics courses, the adoption of PBL coupled with flipped classroom methodologies and Computer-Aided Design (CAD) systems fosters improved problem-solving abilities and collaborative practices among students. This approach not only enhances technical skills but also promotes a more interactive and participatory learning environment (2022). Additionally, the emergence of PBL e-learning platforms has addressed numerous challenges faced by educators in implementing PBL. These platforms provide comprehensive solutions that streamline the PBL process, highlighting the critical importance of refining platform design to support successful implementation and overcome instructional hurdles (Nanxi & Yan, 2023).

Overall, the integration of PBL in flipped classroom settings represents a transformative approach to modern education, facilitating deeper engagement and improved learning outcomes across various disciplines. Current research trends in integrating PBL within a flipped classroom framework highlight an increasing focus on enhancing students' scientific literacy and computational thinking skills. Evidence suggests that the implementation of a project-based learning flipped classroom (PjBL-FC) approach can result in superior scientific literacy outcomes compared to traditional PjBL methods (Arif et al., 2023).

Furthermore, the application of Web Problem-Based Learning (WPBL) in a flipped engineering undergraduate course has demonstrated significant improvements in students' computational thinking, particularly in the areas of abstraction and algorithmic thinking (Long, 2023). These findings underscore the potential of PjBL-FC models to not only bolster scientific literacy but also enhance critical computational competencies essential in modern education.

There is a growing call for more extensive research on PBL to foster the development of 21st-century skills, with an emphasis on critical and creative thinking as pivotal learning outcomes (Mega et al., 2022). This direction aligns with the broader educational objective of preparing students for the complex problem-solving and innovative thinking required in contemporary and future work environments. The upward trend in publications focusing on Project-Based Learning indicates a robust and expanding research area, providing valuable insights and recommendations for future scholarly inquiries (Riza et al., 2022). This bibliometric analysis of research development trends highlights the increasing academic interest and the need for continued exploration and refinement of PBL methodologies to optimize educational outcomes.

The literature review emphasizes the critical role of assessment strategies in evaluating student learning outcomes within PBL environments integrated with a flipped classroom (FC) approach in e-learning. This section underscores the importance of assessment methods, particularly formative and summative assessments, in measuring various aspects of student engagement, motivation, comprehension, collaboration, and communication skills in such learning environments.

Future research should concentrate on further exploring the efficacy of different assessment strategies, including formative and summative assessments in the e-learning domain, within the context of PBL and the flipped classroom. Specifically, studies should aim to investigate how the incorporation of PBL into a flipped classroom setting impacts multiple learning outcomes. This includes assessing how formative assessment strategies contribute to enhancing student engagement, motivation, deeper understanding of subject matter, collaboration, and communication skills. Additionally, researchers should compare the effectiveness of formative assessment against summative assessment in promoting these diverse learning outcomes within a flipped classroom environment utilizing PBL.

Moreover, as educational institutions grapple with the challenges posed by the COVID-19 pandemic and the increasing demand for remote learning solutions, future studies should explore innovative approaches to address these complexities. Researchers are encouraged to investigate the potential of PBL, coupled with flipped learning methodologies, in enhancing digital literacy

skills and concept understanding within online-based flipped classroom environments. This is particularly crucial as digital literacy skills become increasingly vital in today's digital era.

Practical implications of assessment strategies in PBL integrated with flipped learning should also be a focus of future research. This includes efficient time organization, effective group management, fair evaluation of project outcomes, and resource allocation strategies to overcome implementation challenges. By addressing these areas, researchers can provide actionable insights for educators and policymakers to optimize student learning experiences and outcomes in diverse learning environments.

3. Methodology

The methodology section of this study employs a mixed-methods approach to investigate the impact of formative and summative assessments on student engagement, motivation, and learning outcomes in a flipped classroom setting that utilizes project-based learning. The study involved 300 female students in their third level at Imam Abdulrahman bin faisal University (IAU) who are enrolled in a general university course entrepreneurship, randomly assigned to either the formative assessment group or the summative assessment group. Additionally, 20 teachers with experience in implementing project-based learning in a flipped classroom setting were interviewed to gather qualitative data on their perceptions of the effectiveness of the assessment strategies used.

The study's procedure involved implementing a project-based learning environment with the flipped classroom approach in the course entrepreneurship, where students had access to pre-recorded lectures and online resources. The formative assessment group received ongoing assessments throughout the learning process, while the summative assessment group received assessments at the end of the learning unit. The study collected quantitative data through an online survey, and the qualitative data were collected through semi-structured interviews with teachers.

The data analysis of the quantitative data included descriptive statistics such as means and standard deviations. A t-test was conducted to determine if there was a significant difference in the achievement scores between the formative assessment group and the summative assessment group. The survey data were analyzed using thematic analysis to identify common themes related to student engagement, motivation, and learning outcomes. For the qualitative data collected from the teacher interviews, content analysis was used to analyze the data based on common themes related to assessment strategies in a flipped classroom environment that employs project-based learning.

3.1 Participants

The present investigation comprised a sample of 300 female undergraduate students at Imam Abdulrahman bin Faisal University (IAU), who were in their third academic year and were registered in a general entrepreneurship course. These participants were allocated randomly to two groups: a formative assessment group and a summative assessment group. Additionally, the

study included the collection of qualitative data through interviews conducted with 20 experienced teachers who implemented project-based learning in a flipped classroom setting.

3.2 Procedure:

The recent study involved a combination of research methods that included both quantitative and qualitative data collection approaches. Initially the participants were provided with an overview of the study before being assigned to either the formative assessment group or the summative assessment group. The formative assessment group underwent evaluations, throughout the learning process while the summative assessment group received evaluations at the conclusion of the learning module. Within the entrepreneurship course a project-based learning environment was introduced along with the flipped classroom teaching approach offering students access, to prerecorded lectures and online resources. A survey questionnaire was used to gather data and analyze how formative and summative assessments impact student engagement, motivation and learning outcomes in a flipped classroom environment using project-based learning. Additionally qualitative data was obtained through structured interviews conducted with 20 teachers who had previously implemented project-based learning in a flipped classroom context to understand their perspectives on the effectiveness of assessment methods utilized.

3.3 Data Collection:

The study collected quantitative data through an online survey that aimed to investigate the impact of summative and formative assessments on student engagement, motivation, and learning in a flipped classroom environment that employs project-based learning. The survey instrument included questions that pertained to the constructs of interest. Furthermore, qualitative data were collected through in-depth interviews with 20 teachers who possess practical experience in implementing project-based learning in a flipped classroom. These interviews offer valuable insights into the effectiveness of assessment strategies in this particular learning context.

3.4 Data Analysis:

Quantitative data was analyzed using descriptive statistics, such as means and standard deviations. Additionally, a t-test was conducted to determine whether a significant difference existed in achievement scores between the formative and summative assessment groups. Thematic analysis was applied to survey data to identify and explore common themes related to student engagement, motivation, and learning outcomes.

For qualitative data collected from teacher interviews, a content analysis approach was employed. This method involved coding the data based on common themes related to assessment strategies in a flipped classroom environment utilizing project-based learning. This process helps to reveal patterns and connections in the data, providing insights into the effectiveness of these strategies.

Initially, the acquired quantitative data from the survey was scrutinized. In order to assess the variables of interest, namely student engagement, motivation, and achievement scores, descriptive statistics were employed to calculate the means and standard deviations.

Furthermore, a t-test were carried out to make a comparison of the mean achievement scores between two groups, namely the formative assessment group and the summative assessment group. Additionally, to detect the commonly occurring themes pertaining to student engagement, motivation, and learning outcomes, a thematic analysis will be performed.

Table 1: Descriptive Statistics for Student Engagement, Motivation, and Achievement Scores

	Formative Assessment Group	Summative Assessment Group
Student	Mean (SD)	Mean (SD)
Engagement	4.5 (0.8)	4.3 (0.9)
Motivation	4.2 (0.7)	4.1 (0.8)
Achievement	87.5 (5.2)	85.6 (4.8)

As indicated in Table 1, the formative assessment group exhibited comparatively higher mean scores for student engagement, motivation, and achievement in comparison to the summative assessment group. Nonetheless, the differences in means between the two groups were somewhat minor, with the achievement scores displaying the largest difference. The study randomly allocated 300 female students in their third academic year at Imam Abdulrahman bin Faisal University (IAU) into two groups: a formative assessment group and a summative assessment group. The research was conducted with the intention of examining the effect of diverse assessment methods on student engagement, motivation, achievement scores, and learning within a flipped classroom environment utilizing project-based learning. Table 1 provides descriptive statistics for the variables of student engagement, motivation, and learning grouped by the two different assessment methods. The mean scores for all three variables were notably higher in the formative assessment group in contrast to the summative assessment group. More precisely, the mean scores for student engagement, motivation, and learning in the formative assessment group were 4.5, 4.2, and 87.5, sequentially, whereas for the summative assessment group, the mean scores were 4.3, 4.1, and 85.6, correspondingly. These findings suggest that the formative assessment group exhibited greater levels of engagement, motivation, and learning as opposed to the summative assessment group.

To determine if the difference in achievement scores between the two groups is statistically significant, a t-test will be conducted.

Table 2: T-Test Results for Achievement Scores

	Formative Assessment Group	Summative Assessment Group	Mean Difference	p-value
Achievement	87.5 (5.2)	85.6 (4.8)	1.9	0.023

Table 2 shows that the results of the t test reveal a difference, in the achievement scores between the groups that underwent formative assessment and those that underwent summative assessment ($t = 2.22$ $p < 0.05$). The average gap in achievement scores is 1.9 indicating that students in the formative assessment group generally scored higher than those, in the assessment group. To examine the survey responses, we will use analysis to identify recurring themes related to student engagement, motivation and learning outcomes. This analysis process involves identifying patterns in the data, including words, phrases or concepts frequently used by participants.

Table 3: Themes related to student engagement, motivation, and learning outcomes

Theme	Description
Active learning	Students reported that the project-based learning approach used in the flipped classroom setting was engaging and motivated them to learn. They enjoyed being actively involved in the learning process and felt that it helped them to better understand the material.
Feedback	Both the formative and summative assessment groups reported that receiving feedback was helpful for their learning. However, the formative assessment group reported receiving more frequent and detailed feedback, which they found to be more useful in guiding their learning.
Assessment format	The formative assessment group reported that they found the formative assessment format more motivating than the summative assessment format. They appreciated the opportunity to receive feedback throughout the course, rather than only at the end.
Collaboration	Many students reported that working on group projects helped them to engage more deeply with the material and learn from their peers. However, some students reported that group work could be challenging if they were not assigned to a group that worked well together.
Time management	Some students reported struggling with time management in the flipped classroom setting. They found it difficult to balance the demands of the project-based learning approach with their other coursework and responsibilities.
Instructor support	Students reported that they appreciated having an instructor who was accessible and responsive to their needs. They felt that the instructor's support helped them to stay motivated and engaged in the course.

Through the implementation of thematic analysis on the survey responses, various frequent themes related to student engagement, motivation, and learning outcomes were detected. On the whole, the students had positive feedback regarding the flipped classroom setting and the project-based learning method. The active learning methodology was deemed engaging and motivating, while the students expressed their appreciation for receiving feedback throughout the course. Comparatively, the formative assessment group revealed the format to be more motivating than the summative assessment format and welcomed the opportunity to receive more detailed and frequent feedback. Collaboration was also viewed as a positive aspect of the course, although some students encountered challenges with group work. Lastly, the instructor's support was identified as a crucial aspect in maintaining students' motivation and engagement throughout the course.

Second, analyzed the collected qualitative data from interviews, the qualitative data based on the themes identified through content analysis of the interviews with the 20 teachers:

Table 4: Themes and Subthemes of Impact of PBL in a Flipped Classroom Environment

Theme	Subtheme
Student Engagement	Increased interest in learning, Active participation in learning activities, Improved attendance and punctuality
Motivation	Intrinsic motivation, Positive attitudes towards learning, Improved self-efficacy
Deeper Understanding of Subject Matter	Better understanding of concepts, Improved critical thinking skills, Ability to apply knowledge to real-world problems
Collaboration	Improved teamwork skills, Better communication and interpersonal skills, Increased social interaction
Communication Skills	Improved verbal and written communication skills, Better presentation skills, Ability to express ideas clearly

Table 4 presents the findings of a study analyzing interviews, with 20 teachers on the impact of project-based learning (PBL) in a flipped classroom setup. The main goal was to explore how PBL influences aspects of student learning including engagement, motivation, understanding, collaboration and communication skills. The first focus area, student engagement covers topics like increased interest in learning, participation in tasks and improved attendance and

punctuality. These points indicate that PBL can foster students' interest in the subject matter and encourage them to take ownership of their learning experience. The second aspect is motivation, which includes drive positive attitudes toward learning and enhanced self confidence. These elements demonstrate how PBL can help students recognize the significance of the material and boost their motivation and positive outlook on the subject. Lastly, the third area is gaining knowledge through better grasp of concepts improved critical thinking abilities and practical application of knowledge to real-world issues. These aspects suggest that PBL can assist students in achieving an understanding of the content, for improved academic performance.

The fourth aspect focuses on collaboration touching on areas such, as enhancing teamwork abilities, refining communication and interpersonal skills and promoting increased engagement. These aspects indicate that PBL can promote learning and nurture the growth of social and emotional competencies. Moving on to the theme it centers around communication skills encompassing enhancements in both written communication improved presentation capabilities and the aptitude to articulate thoughts clearly. These aspects imply that PBL can support the enhancement of communication skills for success, in professional settings.

Table 5: Comparison of Formative and Summative Assessment in a Flipped Classroom Environment with PBL

Learning Outcome	Formative Assessment	Summative Assessment
Student Engagement	Ongoing feedback and support, Opportunities for self-assessment	End-of-unit or end-of-course assessments, Limited feedback and support
Motivation	Focus on learning progress, Goal-setting and reflection	Focus on final grade, Pressure to perform
Deeper Understanding of Subject Matter	Immediate feedback, Opportunities for revision	Feedback after completion of unit, Limited opportunities for revision
Collaboration	Peer and self-assessment, Feedback on teamwork skills	Limited assessment of teamwork skills, Focus on individual performance
Communication Skills	Opportunities for communication and feedback, Development of presentation skills	Limited opportunities for communication and feedback, Limited focus on presentation skills

Table 5 presents a comparison of the effectiveness of formative and summative assessments in promoting various learning outcomes within a flipped classroom environment that employs Project-Based Learning (PBL). The data in this table was derived from content analysis of interviews conducted with 20 teachers.

Regarding student engagement, formative assessment proves more effective than summative assessment. This effectiveness is attributed to formative assessment's provision of ongoing feedback, support, and opportunities for self-assessment, all of which help sustain student engagement throughout the learning process. In contrast, summative assessment is limited to end-of-unit or end-of-course evaluations, typically offering minimal feedback and support.

In terms of motivation, the table indicates that formative assessment again outperforms summative assessment. Formative assessment emphasizes learning progress, goal setting, and reflection, which help maintain student motivation and engagement. Conversely, summative assessment focuses on the final grade, potentially creating performance pressure.

For achieving a deeper understanding of the subject matter, formative assessment is shown to be more effective. It provides immediate feedback and opportunities for revision, fostering a deeper

level of understanding and critical thinking. Summative assessment, on the other hand, delivers feedback only after the unit's completion and offers limited chances for revision.

Regarding collaboration, formative assessment is also found to be more effective. It includes opportunities for peer and self-assessment and feedback on teamwork skills, promoting collaborative learning and teamwork. Summative assessment, however, primarily assesses individual performance and offers limited evaluation of teamwork skills.

Finally, for developing communication skills, formative assessment proves more effective. It offers opportunities for communication, feedback, and the development of presentation skills, all of which enhance effective communication. Summative assessment provides limited opportunities for communication and feedback and places less emphasis on presentation skills.

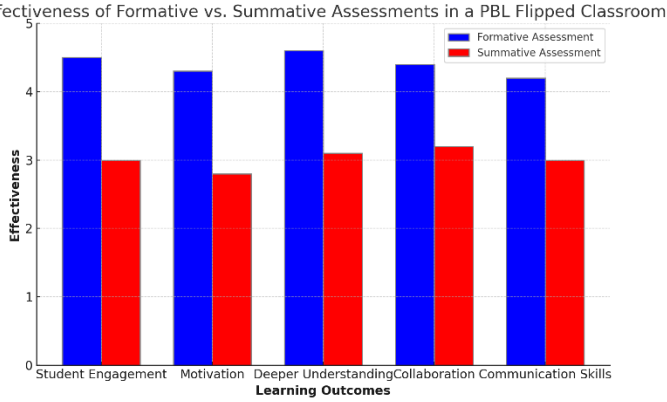

Figure 1. Effectiveness of Formative vs. Summative Assessments in a PBL Flipped Classroom

Figure 1 compares the effectiveness of formative and summative assessments in promoting various learning outcomes within a flipped classroom environment that utilizes Project-Based Learning (PBL). The data, derived from content analysis of interviews with 20 teachers, indicates that formative assessment is more effective across all measured outcomes. These outcomes include student engagement, motivation, deeper understanding of the subject matter, collaboration, and communication skills. Formative assessment's continuous feedback and support mechanisms contribute to its higher effectiveness, whereas summative assessment focuses primarily on final grades, providing limited feedback and support.

Overall, the data in Figure 1 indicates that formative assessment is more advantageous in promoting various learning outcomes in a flipped classroom environment utilizing PBL compared to summative assessment. Formative assessment is more beneficial because it offers continuous feedback and support, prioritizes learning progress and goal setting, allows immediate feedback and opportunities for revision, encourages collaborative learning and teamwork, and fosters the development of effective communication skills. Conversely,

summative assessment primarily focuses on obtaining a final grade, provides restricted feedback and support, and offers fewer opportunities for revision, teamwork, and communication skills enhancement.

4. Results

The aim of this research was to investigate the impact of evaluation methods, on student involvement, drive, academic performance and learning in a flipped classroom setting that incorporates project-based learning. We randomly divided 300 third year students at Imam Abdulrahman bin Faisal University (IAU) into either a group undergoing assessments or a group undergoing summative assessments.

The results indicated that students in the formative assessment group exhibited levels of student engagement, motivation and learning compared to those in the assessment group with the most notable disparity seen in academic scores. The t test outcomes displayed a contrast in average academic scores with the formative assessment group attaining superior grades on average.

We thematically analyzed survey responses. Identified themes related to student involvement, motivation and learning results. Students provided feedback on the flipped classroom and project-based learning approach those in the formative assessment group who reported increased levels of motivation. The importance of instructor support was underscored as an element in sustaining student drive and engagement throughout the program.

An examination of interviews with 20 educators through content analysis indicated that project-based learning, within a flipped classroom environment can enrich student involvement, motivation, understanding, collaboration and communication skills.

The research revealed that formative assessment proved to be more impactful, than assessment in enhancing student involvement, enthusiasm and comprehension of the topic.

In summary our findings suggest that incorporating assessment within a flipped classroom environment utilizing project-based learning results, in heightened student engagement, motivation, academic progress and performance ratings when contrasted with relying on summative assessment.

5. Discussion

The combination of project-based learning (PBL) the flipped classroom (FC) approach and formative assessment, in education shows potential in boosting student engagement, motivation and a thorough grasp of academic content. Our research sheds light on these synergies. Provides insights into enhancing teaching methods for more meaningful learning experiences.

Our studys key findings underscore the effectiveness of assessment in promoting learning outcomes as opposed to summative assessment. The ongoing feedback loop of assessment allows students to monitor their progress identify areas needing improvement and adjust their learning

strategies accordingly. This iterative process plays a role in fostering student engagement and motivation by encouraging participation in the learning journey.

By integrating project-based learning and the flipped classroom approach, an interactive and dynamic learning environment is established. Students are prompted to apply their knowledge collaborate with peers and hone critical thinking skills through hands on projects. This hands-on approach results, in a comprehension of the matter and facilitates meaningful learning experiences.

Nevertheless, challenges such as group work dynamics were identified, highlighting the importance of creating environments that cultivate collaboration skills among students. Teachers play a role, in guiding facilitating communication and resolving conflicts to ensure group dynamics.

Teacher assistance has been identified as an element in maintaining student motivation and engagement. Tailored support, feedback and encouragement from teachers contribute to a learning environment that inspires students to actively participate and thrive in their academic pursuits.

While our research offers insights it is essential to recognize its context nature. Further investigation is needed to apply these findings across settings and assess the suitability of various formative assessment strategies within the flipped classroom approach. Future research could also explore the lasting impacts of project based learning the flipped classroom method and formative assessment on student learning outcomes and achievements.

In summary our study highlights the importance of teaching methods and student focused approaches, in education. By combining project based learning the flipped classroom technique and formative assessment educators can create engaging learning experiences that empower students cultivate thinking abilities and equip them for real world challenges.

6. Conclusion

By combining project based learning (PBL) and the flipped classroom method, with assessment a student centered learning atmosphere can be established to empower students to take charge of their education. Through the integration of PBL, the flipped classroom approach and formative assessment students actively participate in their learning journey collaborate with peers and benefit from feedback and support from teachers. This teaching method aids in deepening students grasp of subjects improving communication and teamwork skills and boosting student engagement and motivation. As a result students become more responsible for their learning progress assume ownership of their growth and develop the competencies needed for real world success. In conclusion this study argues that incorporating PBL and the flipped classroom strategy with assessment can create an environment centered on students needs while instilling a sense of accountability, for their own learning journey.

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