DEVELOPING A CONSTRUCTIVELY ALIGNED LEARNING-BY-DOING (LBD) MODEL FOR 21ST CENTURY EDUCATION AT HCT, UAE

A Thesis submitted by

Ghassan Frache, B.Sc., M.Sc., M.Ed.

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ABSTRACT

In the context of modern pedagogy, educators and academics have been placing greater emphasis on the value of Learning-By-Doing (LBD) and 21st Century Skills. This thesis presents an exploration of the existing approach to LBD practices and 21st Century Skills based on research conducted at one of the premier higher education institutions for engineering in the United Arab Emirates (UAE). This thesis presents an analysis of the current understanding of LBD from the viewpoint of the institution's leadership and faculty, in response to the overall research question: What constructively aligned Learning-By-Doing (LBD) pedagogical model, incorporating 21st Century Skills, can be developed for enhancing the teaching of engineering at HCT, UAE?

It seeks to identify the LBD practices that are being successfully implemented and the 21st Century Skills that are being taught and assessed, drawing substantially from the vantage point of instructors and students. By exploring these areas in a top-ranked institution in the UAE, this thesis seeks to cast a broader light on the perspectives and practices of similar universities and engineering programs in the Emirates. The study employed a mixed methods approach in which students participated in an online survey while the engineering dean and instructors took part in open-ended, semi-structured interviews. The findings from the two sets of data collection activities were merged resulting in the emergence of themes, which were then used as the basis for formulating five basic principles. These principles were used to guide the development of a four-stage (Explore, Do, Reflect and Apply) LBD learning model. Rooted in the literature of Kolb, Dewey and Lewin, this LBD Model provides extensive structure and specificity for curriculum development, lesson planning, teaching and assessment of content, and professional learning, with the potential to lead an inclusive implementation of LBD practices and 21st Century Skills going forward.

CERTIFICATION PAGE

This Thesis is entirely the work of Ghassan Frache except where otherwise acknowledged. The work is original and has not previously been submitted for any other award, except where acknowledged.

Principal Supervisor : Associate Professor Joan Conway

Associate Supervisor : Dr Marian Lewis

Student and supervisors signatures of endorsement are held at the University.

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CHAPTER 1: INTRODUCTION

1.1. Introduction

This chapter provides background and context for the current study by discussing the United Arab Emirates' Vision 2021 (Vision 2021, 2014) and its implications for Higher Education in the country through the scope and applicability of Learning-By-Doing (LBD) as a mandated pedagogical model in colleges of higher education. The chapter also makes a case for the inclusion of 21st Century Skills and their implementation and assessment within the framework of LBD practices, as the solution for achieving Vision 2021's guidance on aligning learning with industry needs. The research was conducted in an Engineering Institute that had introduced the LBD model in 2011, but was thought to be lacking in formal structure, guidance or documentation for its implementation or assessment. It was this realization that created a perceived need for an exploration of LBD implementation at the target institute.

The chapter, therefore, presents a brief overview of LBD as practiced in the target institute, and lays the groundwork for establishing the need for the current study. It also presents the research objectives, the overall research question, and research sub-questions that guided the conduct of the data collection and analysis. Chapter 1 also situates the research amidst identified gaps in the existing literature on LBD as well as providing far-reaching implications for the institute under study in the form of the development of a customized LBD model incorporating 21st Century Skills.

1.2. Research Background

1.2.1. The UAE.

The United Arab Emirates (UAE) is a federation of seven emirates (Abu Dhabi, Ajman, Dubai, Fujairah, Ras Al Khaimah, Sharjah and Umm al-Quwain) and is located in the Arabian Gulf region neighboring Oman to the East and North and Saudi Arabia to the West and South. The area is approximately 75,000 square kilometers with Abu Dhabi Emirate being the largest covering approximately 65,000 square kilometers. The

Western Region of Abu Dhabi, named Al Gharbia (now re-named as Al Dhafra), is the immediate context of this study. It covers 75% of the land area of the UAE, has 9% of the population and produces 46% of the GDP of the country's economy (Noack, 2009). Like the rest of the country, Abu Dhabi and Al Dhafra, have invested in the development of primary and secondary schools as well as institutes for higher education. The country's education market stood at $4.4 billion in 2017 and is expected to grow to $7.1 billion in 2023 (Hoteit, El Hachem, Erker, & Farah, 2018). Vision 2021 led to the development of Education 2020 by the Ministry of Education, UAE, which aimed to restructure and reform the educational system by amending licensing and evaluation systems, re-designing curriculums and investing in teachers' professional development and training (Export.gov, 2019).

1.2.2. UAE Education and Vision 2021.

The UAE has the largest economy after Saudi Arabia in the Gulf region, and it ranks as the 14th best nation worldwide for doing business, based on its economy and regulatory environment (World Bank Group, 2014)). The country is poised to take advantage of Industry 4.0 (Elnashar, 2014) and is heavily investing in innovative technologies for healthcare, education, and citizen wellbeing. However, according to current estimates, only 10 % of the population of the UAE consists of native Emiratis, while 90% are non-natives (The World Bank Annual Report, 2017). The influx of non-Emirati residents in the UAE has substantially contributed to the economy and development of the country, but there has been a desire and exigency to empower Emirati natives to take positions of leadership and contribute to the country's growth.

The 2003 Emiratization program was developed to train Emiratis to become competitive, and to equip them with the skills, knowledge, and capabilities of the changing world. The Emiratization program is aligned with the UAE Vision 2021, which aims to develop and train Emiratis for taking up jobs in the country. A significant aspect of both Vision 2021 and the Emiratization drive is to enhance human capital capabilities through developing a robust educational system and to invest in training and development of young Emiratis. The improvements in education are directed towards

instilling the values of productivity, competitiveness, and accountability, as well as developing skills and a knowledge base for future employability (Vision 2021, 2014).

Higher education has received additional focus, as it has the potential to act as a launch pad that will enable the students to function and succeed in the real world. It is here, at the higher educational level, that the students must enrich their minds with the skills and knowledge, and be able to apply their learning to real-life situations. Identifying the crucial position held by the institutes of higher education in the lives of students, Vision 2021 developed a broad set of guidelines to ensure that the universities and colleges align their courses and teaching approaches with industry needs (Vision 2021, 2014, p. 16).

Educational reforms, especially in higher education, are therefore geared toward developing relevant capabilities and skills in students that can assure they have confidence and knowledge to succeed in their futures. The drive for the reformation of education is also guided by the UNESCO (1998) Higher Education in the Twenty-First Century Declaration, stating that "there is a perceived need for a new vision and paradigm of higher education, which should be student-oriented" (p. 1). UNESCO'S declaration recommends a paradigm shift in the approach to curriculum development – from a focus on enabling mastery of certain subjects and skills to the development of cognitive abilities for life-long learning, development of an open frame of mind, ethical orientation and enhancement of skills like creativity, critical thinking, team working, and communications.

To support the paradigm shift in curriculum, the professional learning and development of teachers are also called into action, so that instructors are equipped with an understanding of how to implement the curriculum and deliver student-centered learning.

1.2.3. Learning-By-Doing (LBD).

While having a vision and developing a set of guidelines is one thing, enacting the vision and translating it into results is a different proposition. It can, therefore, be

argued that teaching methods and approaches need to be aligned at the ground level with the requirement of matching the students' learning with the practical needs of jobs in the future. The current study situates itself within the context of this need, where the institutes of higher education require a curriculum program that can meet the industry alignment need while at the same time enable effective learning by students. This study specifically targets an engineering institute in the UAE that had endeavored to develop an aligned learning framework, using a Learning-By-Doing (LBD) approach.

Learning-By-Doing is one method that has increasingly gained a reputation for facilitating learning through empowering the learner (Cantor, 1995; Roberts, 2009; Schank, 1995). An LBD approach falls within the realm of more authentic, relevant learning that has been a focus for educators since the time of John Dewey in the early part of the last century. Dewey's (2009) concept of "learning by doing" was based on his understanding that people learn best when they are actively involved in tasks that have meaning and importance to them.

LBD, therefore, aims to address, 'how people learn'. 'How people learn' has been at the core of Jean Piaget's (1964) cognitive development stages, and its understanding has been enhanced through constructs like Howard Gardner's (1999) multiple intelligences, and Bloom's (1956) taxonomy, and works of the National Research Council (2000).

Dewey's work gave more practical insights into how to facilitate learning – more aptly, through the use of the mind, hands, and heart (Dewey, 2009). Learning-By-Doing is also manifested in many of today's learning theories. For example, experiential learning, under which falls active learning (whose subsets include cooperative learning and collaborative learning) and service learning, all exemplify the principle of Learning-By-Doing (Pham, 2011). According to Voogt and Roblin (2010), for students to be successful in the 21st Century, not only are specific skills necessary but these need to be taught through (and are best supported by) "specific pedagogic techniques, such as problem-based learning, cooperative learning, experiential learning, and formative

assessment" (p. 29), all of which can again be seen as encompassed in the approach of Learning-By-Doing (Pham, 2011).

LBD practices are being referenced in mainstream pedagogy by various descriptors such as "hands-on learning", "active learning", "experiential learning", or "cooperative learning" (Johnson, Johnson, & Holubec, 2008), and "collaborative learning" (Smith & MacGregor, 1992). These descriptors reflect the diverse perceptions of Learning-By-Doing, and in many ways, illustrates progressive schooling approaches in a context greatly influenced by recent trends toward efficiency, standardization, and control (Roberts, 2009).

Owing to the relevance of an LBD approach to ensure a learning experience that is expected to prepare students to actively and successfully participate in their future profession and take on roles of leadership and responsibility, the institute targeted in this research had also initiated a program that was aligned with LBD. Though LBD practices are a shift away from the teacher-centered or lecture-centered learning to student-centered learning, it has been observed by several scholars that the concept of 'doing' has not been well-defined or structured into specific activities (Roberts, 2009), which make it difficult to implement. According to Roberts (2009), educators often have more of a "common sense" notion of LBD, and often do not take into account its fuller context. The sort of learning that involves active engagement of the students with the learning event and gives the students a chance to acquire and apply knowledge and skills in a relevant setting.

Similarly, being an instructor and later an academic manager at the Institute for several years allowed the researcher to be privy to certain observations that raised questions regarding the accuracy, credibility and implementation of LBD, which warranted further investigation and development for enhanced implementation.

1.2.4. 21st Century Skills.

Since LBD is a basic pedagogical approach informing 'how to learn', the second essential question to ask is, 'what to learn,' which calls for an underscoring of specific

and definable skill-sets that must be learned by students. As a result, the role and application of 21st Century Skills is seen as being essential to carrying out the basic LBD approach. Several 21st Century Skills frameworks (these are discussed fully in Chapter 2), explain how they prepare the students, workers, and the citizens to triumph in the universal race, creating central economic competitiveness. Partnership for 21st Century Skills in the United States of America (US) has emerged as the leading advocacy organization focused on infusing 21st Century Skills into education practice (Partnership for 21st Century Skills, 2006).

Other US organizations such as the Center for Public Education (CPE) (2009), the International Society for Technology in Education (ISTE) (2007), and the American Association of Colleges and Universities (2007) have made 21st Century learning integral to their educational discourse. International bodies such as the European Union (2006), business interest groups such as the Organization for Economic Cooperation and Development (2005), and the Metiri Group and NCREL (2003) that provide evaluation and assessment tools for digital learning, also point out the importance attached to this area. Adamson and Darling-Hammond (2013) claim that the incorporation of 21st Century Skills into the curriculum has widespread currency in educational systems including the United States, England, Germany, Australia, Norway, Ireland, Costa Rica, Finland, and Singapore.

The concept of 21st Century Skills has led to a different way of looking at aspects of teaching and learning as envisaged by these frameworks as well as by legislation like the No Child Left Behind (NCLB, 2002) and the work of the National Research Council (2013). A large number of skills are found to be relevant in the context of the 21st Century - global awareness; economic, financial, entrepreneurial and business literacy; civic literacy; awareness of health or wellness, critical thinking and problem-solving skills; creativity and innovation; communication; collaboration; contextual learning; media literacy and information processing skills; life skills; ethical orientation; and others (Partnership for 21st Century Skills, 2006).

However, a review of the literature again revealed that the implementation and assessment of these skills had not been structured or conceptualized in a manner that can be used to support learning in schools directly. At the target institute, the 21st Century Skills are identified and defined and are intended to be delivered and assessed through the implementation of Learning-By-Doing practices. However, no formal evaluation or assessment of the success of 21st Century Skills using LBD practices has been carried out there. This study has sought to explore the success of the application of 21st Century Skills and LBD practices in the engineering department at the institute and create a model of LBD that can enable better integration and acquisition of 21st Century Skills.

Also relevant to this study is Pham's (2011) argument that Western student-centered learning practices should be applied with circumspection, giving due consideration to the culture and values of non-Western countries. Universities should adopt learning strategies that will work in harmony with cultural values rather than against them (Pham, 2011). The need to culturally contextualize LBD practices to make them relevant to the UAE's Islamic culture was also considered to be of relevance developing the curriculum and pedagogical approach for the targeted institute, but no documentation was found that indicated such an attempt was previously done.

The current research was aimed at assessing the effectiveness of the existing implementation of LBD practices and 21st Century Skills, through an assessment of the perceptions of the dean, the instructors, and students. The research leads to insights regarding the various limitations in the successful implementation and also lead to the development of a new pedagogical model using both LBD practices and 21st Century Skills.

The next section now moves to provide a background about the institute under study, and the LBD program that it had initiated at the time of data collection for this study.

1.2.5. Current LBD Practices and 21st Century Skills at the Target Institute.

The institute at the centre of the current study is a public engineering college in the UAE, was found in 2006. It had adopted a Learning-By-Doing (LBD) pedagogical philosophy in 2011 in response to the UAE Vision 2021 that called for enriching the learning of the students with the skills that nation needs. The selected institute's mission is stated as its "commitment to aligning its academic programs with specific industry needs and producing entry-level Emirati graduates to meet market demands" (HCT Strategic Plan 2012-2017, 2014, p. 3).

The institute's instructors are therefore mandated to use the pedagogical philosophy in their teaching strategies for students to acquire "essential knowledge and skills through active, self-reflective engagement, that increases the chance that the concepts will be learned, remembered, and used in a variety of situations (by the students)" (HCT Strategic Plan 2012-2017, 2014, p. 3). The institute's strategic plan is supported by a learning model that specifies desired outcomes that can ensure that the graduates have the skills necessary to enable the country's growth and development in the 21st Century. It was within this context that the institute had been using the LBD mandate over a year at the time of collecting the data for this study. Anecdotal evidence from discussions with instructors revealed that they had their understandings of LBD and how it should be applied to their classes, but was not able to refer to any specific framework or document for guidance.

Additionally, while graduate outcomes in the institute's learning model are aligned with some 21st Century Skills, which are explicitly identified, the curriculum did not include core learning expectations in support of the desired outcomes. This study was motivated by an implication that in the absence of clear linkage between the core learning expectations and desired outcomes, there was lack of explicit guidance for driving the curriculum, delivering the instruction, and conducting assessment practices in classrooms. This was in tandem with the existing literature on LBD as pointed out by Roberts (2009). One year into the LBD mandate, it was realized that while it was

recognized that LBD practices and 21st Century Skills needed to be implemented, it was unclear whether they were adequately practiced. This was especially pertinent in the absence of a sound and robust definition or framework for LBD. Also, while the lack of a common LBD definition and approach may be seen as enabling the exercise of professional freedom by the instructors (Roberts, 2009), it may also contribute to a mixture of strategies that may or may not promote the institute's vision and mission.

This research, therefore, investigated how LBD is understood and practiced in the institute to enable learning through 21st Century Skills. It also evaluated the scope of explicitly incorporating 21st Century Skills into the institute's curriculum using constructive alignment principles as a pattern for instructional designs (Roberts, 2009). It was further considered that an investigation into how LBD is defined and implemented at the institute would help to identify the successful practices used by instructors and introduce complementary ideas about how LBD might best be implemented. Consequently, the investigation was intended to subsequently help build capabilities in group interpretation, negotiation of shared meaning, and co-construction of problem resolutions, which, as Bridges (2003) states, may provide a source for a better understanding of the professional practice. This speculation led to the formulation of the research purpose.

1.3. Research Purpose

The purpose of this study was to explore how Learning-By-Doing (LBD) is understood and practiced at the institute, and how 21st Century Skills can be explicitly incorporated into LBD practices using constructive alignment (Cropley & Sitnikova, 2005) as a pattern for instructional design (Biggs & Tang, 2007) by drawing upon the collective views of different stakeholders. The study findings were expected to contribute to the development of an explicit engineering LBD model designed to help the instructors to focus teaching, assessment, and other pedagogical activities not only on the principal elements that comprise LBD practices but also on the students' learning of 21st Century Skills.

This research purpose was attained by establishing the main research aim and objectives.

1.4. Research Objectives

The main aim was supported by the objectives of the study as follows:

- To analyze the current understanding of LBD from the perceptions of the engineering college's dean and instructors
- To identify which LBD practices are being successfully implemented in the engineering department, from the perspective of the dean, instructors, and students.
- To identify which 21st Century Skills are taught and which are assessed in the practice of LBD, from the perspective of the instructors and students.

The objectives were stated to emphasize the fact that the research explored the current situation using the perspectives of the research participants. These perspectives were then assessed within the contextual background of the available literature on LBD and 21st Century Skills. To attain these objectives, the following research question and sub-questions were determined.

1.5. Research Questions

The overall research question for this study is:

What constructively aligned Learning-By-Doing (LBD) pedagogical model, incorporating 21st Century Skills, can be developed for enhancing the teaching of engineering at HCT, UAE?

To accomplish this, the following sub-questions were formulated to guide the research further.

Research Question # 1:	What are the current understandings of LBD from the perspective of the dean, and instructors of the engineering institute under study?
Research Question # 2:	From the perspective of the dean, instructors, and students of the engineering institute under study, which LBD practices have successfully been implemented in the engineering department?
Research Question # 3:	From the perspective of the dean, instructors, and students of the engineering institute under study, what 21st Century Skills are taught, and assessed in the practice of LBD?

1.6. Significance of the Study

This research seeks to contribute to the existing literature on LBD implementation by developing a model aligning 21st Century Skills with LBD practices using a constructivist approach. It is intended that such a model might provide a usable, directional, and credible framework that could be used by engineering instructors to enhance teaching and learning at the target institute.

An explicit model for shared understanding, contextualized to how LBD should be applied in the Engineering division at the target institute, would make its practice more focused, and align students' learning with industry needs. This has the potential to contribute significantly to achieving the institute's mission of providing educational experiences that will infuse its graduates with the knowledge, skills, and attributes to effectively contribute to the nation-building process and to help them develop a sense of personal and social responsibility as envisaged in the mission of the target institute (HCT Learning Model, 2006).

By considering the perspectives of students as well as instructors and engineering dean, the current study, contributes to the practical implementation of the newly developed model of LBD.

1.7. Structure of the Thesis

Chapter 1: Introduction

The first chapter presents a discussion on the research background to contextualize the current study. It provides an overview of the UAE as a growth economy and elaborates on Vision 2021 in the context of educational reforms that are being driven in the country. The chapter also discusses LBD and 21st Century Skills briefly and contextualizes them within the selected institute of higher education where the study was conducted. It presents the research purpose, research aim, research objectives, research questions, and enumerates the significance of the study.

Chapter 2: Review of Literature

The second chapter of the study contains a review of the literature. It discusses concepts such as the principle of alignment in instructional design; frameworks for effective pedagogical design; Dewey's classic Learning-By-Doing (LBD) principles; and several others exploring LBD practice; 21st Century Skills frameworks; and relevant 21st Century Skills assessment and evaluation issues. The chapter also presents a critical evaluation of how LBD practices can be aligned with 21st Century Skills.

Chapter 3: Research Methodology

The third chapter discusses the mixed methodology as it is used in the current study and also gives a historical overview of this approach to data collection along with providing a rationale for using the selected approach. The chapter begins with an overview of the research questions and moves on to discuss the research paradigm, mixed methods design typology, data collection techniques, data analysis procedures and finally discusses the reliability and validity aspects of the quantitative data phase as well as trustworthiness and reliability of the qualitative data phase. The chapter ends with a discussion of ethical issues and research limitations.

Chapter 4: Research Findings and Analysis of Quantitative Data

The fourth chapter contains the findings and analysis of quantitative data collected for this study. It discusses the findings that were obtained from the surveys of the engineering students and analyzes the data using Statistical Analysis of Microsoft MS Excel software applications. Statistical analysis is conducted using means, frequencies, proportions, and tests of statistical significance or Standard Deviation. The findings are presented with the aid of graphs and charts and used to discuss students' perceptions of the implementation of LBD and implementation and assessment of LBD practices and 21st Century Skills.

Chapter 5: Research Findings and Analysis of Qualitative Data

The fifth chapter contains the findings and analysis of qualitative data that were collected through semi-structured, one-on-one interviews with the two sets of participants: the engineering institute instructors and the dean. The analysis was undertaken using a manual thematic content analysis that involved reading and re-reading of the interview transcripts, individually as well as together, evaluation of the participants' understandings of LBD, and their perceptions regarding the success of the implementation.

Chapter 6: Merging and Discussion of Results

The sixth chapter of the study is based on the merging of the analysis obtained from the two data sets – qualitative and quantitative. The merging of the findings evolved into the emergence of themes then presented in the form of a comprehensive discussion about the specific context of the study site and the reviewed literature. This chapter also provides the basic content and support for the development of the five Principles that were later used to develop the Proposed Model for LBD and 21st Century Skills implementation at the targeted institute.

Chapter 7: Developing a New LBD Model and Recommendations

The seventh chapter responds to the overarching research question and builds a new constructively aligned LBD Model for the institute. The chapter discusses the development of the New LBD Model, using the five guiding principles identified earlier in the study. The implementation of the LBD model for instructors, curriculum, students, and management are discussed. Teaching with the new LBD model is also highlighted, along with the limitation of the study, recommendations for future research, and reflection.

1.8. Summary

This chapter presents a brief overview of the theories of LBD and 21st Century Skills. The objectives, research question and sub-questions were stated, and the structure of the thesis has been detailed. The next chapter reviews the relevant literature, discussing the principle of alignment in instructional design; guidelines for effective pedagogical design; Dewey's Learning-By-Doing (LBD) principles; 21st Century Skills frameworks; and assessment and evaluation issues. The chapter also presents a critical evaluation of how LBD practices can be aligned with 21st Century Skills.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

The literature review studies relevant research on Learning-by-Doing, particularly as it has been defined through the 20th and 21st centuries. It also presents a comparative view of 21st Century Skills frameworks. Lastly, the researcher submits his analysis of how the current research is positioned within in the literature.

The chapter starts with a discussion of the basic principle of alignment for instructional design, which is used in pedagogical designing in Higher Education contexts (Biggs & Tang, 2007). It proceeds by discussing the elements involved in Dewey's classic Learning-By-Doing (LBD) principle and its several offspring, which draw upon his works (i.e., experiential learning, reflective learning, active learning, service learning) as positioned in the complex 21st Century educational context. The chapter also provides a comparative discussion of several 21st Century learning frameworks offered by different organizations. Finally, it attempts to show how the LBD practices can be blended into a 21st Century learning frameworks, thereby merging the strengths of the two. More specifically, the review of literature is organized into four main sections: (1) the Principle of Alignment in Instructional Design; (2) Theoretical Underpinnings of Learning-By-Doing; (3) 21st Century Skills and (4) LBD and 21st Century Skills.

2.2. The Principle of Alignment in Instructional Design

Biggs and Tang (2007) describe the task of pedagogical design as one of ensuring that there are no inconsistencies between the curriculum taught, the teaching methods used, the learning environment chosen, and the assessment procedures adopted. To achieve complete consistency, educators need to examine very carefully what assumptions they are making at each stage and to align those with their aims and objectives. Thus, Biggs and Tang (2007) maintain that in designing an instructional

model, it is essential first to develop and define learning outcomes that are aimed to be achieved. This enables the educators in selecting appropriate teaching approaches and learning activities that can help students to attain the pre-defined learning objectives. Also, by defining the learning outcomes, educators get guidance and direction for designing suitable assessment tasks which can gauge the attainment of learning objectives.

Biggs and Tang (2007), therefore, guide the development of curriculum in a planned and well-thought-out manner, so that there are clear and direct linkages between the intended goals and the activities performed. The authors also guide design-related decisions based on the constructivist pedagogical methodology, which places the learning and teaching practices at the center of the process of learning. This approach is, therefore geared toward developing curriculums that enable the students to 'do' and perform activities and is consequently phrased as constructive alignment.

Meyers and Nulty (2009) provide five curriculum recommendations for designing a course based upon Biggs and Tang's (2007) approach to constructive alignment. They propose that in order to maximize the quality of learning outcomes, educators need to develop courses in ways that

> …provide students with teaching and learning materials, tasks, and experiences which: (1) are authentic, real-world and relevant; (2) are constructive, sequential and interlinked; (3) require students to use and engage with progressively higher order cognitive processes; (4) are aligned with each other and the desired learning outcomes, and; (5) provide challenge, interest, and motivation to learn. (Meyers & Nulty, 2009, p. 567)

Meyers and Nulty (2009) further suggest using these five principles in a manner that a learning system is developed that encourages students to embrace a deep learning attitude. These five principles are also expected to guide the development of the course's learning outcomes and assessment tasks and create alignment between the two. Acknowledging the complex and often subjective nature of the teaching process, the

authors recommend adapting the five principles to meet individual teachers' strengths and approaches and to contextualize them within the functional requirements and limitations of the learning environment. The learning environment has been discussed as having the potential to encourage deep learning among students by numerous scholars (Houghton, 2004; Kane, 2007; Kember, Ho, & Hong, 2008; Kolb & Kolb, 2005; Newmaster, Lacroix, & Rossenboon, 2006; Revell & Wainwright, 2009). Researchers like Houghton (2004), Kolb and Kolb (2005) and others have found that learning environments play a crucial role in facilitating learning by actively engaging and involving students with a variety of experiences to build their knowledge. Effective learning environments create conditions where students seek out additional meaning and capture deeper understanding through experience, practice, and reflection activities. Revell and Wainwright (2009) also characterize effective learning environments as those that provide alignment between learning objectives, activities, and assessment tasks, and which ensure that the students have clarity on what is expected of them. Moreover, learning environments enable constructive feedback and genuine opportunities for learning in a practical and real-world relevant context and encourage students to develop their independent decision-making capacity.

Meyers and Nulty's (2009) approach, therefore, builds on the five principles of Biggs and Tang's (2007) constructive alignment to guide the development of curriculums that may be relevant for engineering students. Engineering students require clarity of learning objectives and need to apply their conceptual learning in practical settings that are relevant for their future vocation (Cropley & Sitnikova, 2005; Houghton, 2004). It is therefore desirable that academics tasked with developing engineering curriculums should have clarity on learning objectives and be able to create activities that engage students in deep learning and challenge students to acquire a greater understanding and ability to apply their learning.

Educators know students will inevitably tend to look at the assessment and structure of their learning activities to optimize their assessment performance (Cropley & Sitnikova, 2005; Houghton, 2004). Houghton (2004) stresses that engineering

academics must therefore "make sure that the assessment very obviously does test the learning outcomes we want students to achieve, that, by being strategic optimizers of their assessment performance, students will actually be working to achieve the intended learning outcome" (Houghton, 2004, p. 27).

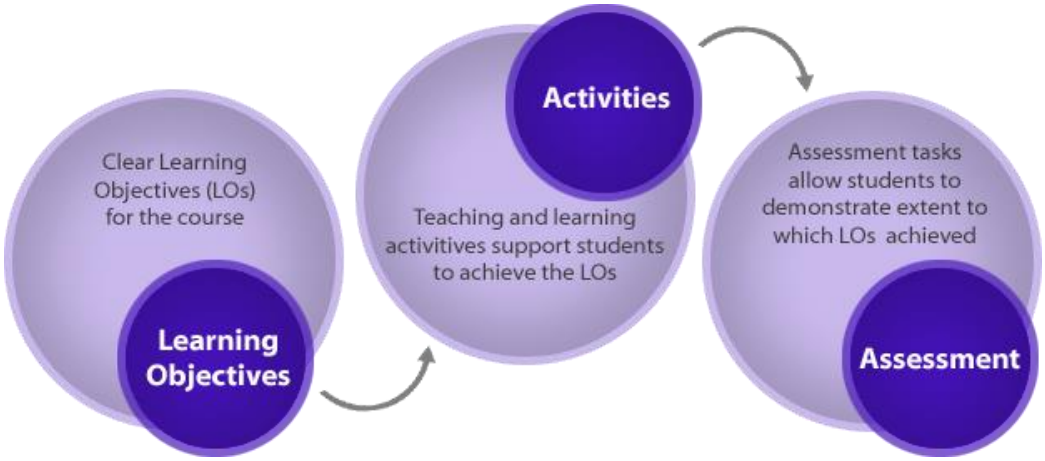
Houghton (2004) further builds Biggs and Tang's (2007) four levels of thinking about teaching and learning. These levels range from Level 1 where the students are delivered lectures, and they are expected to just passively learn the content; to Level 4, where the students are encouraged to take control and manage their learning. In between, Level 2 this is when the teaching is the focus, and it is the teacher's performance that is at the center of the learning process; and Level 3, where the emphasis is placed on learning through suitable activities, directed by the teacher. In most engineering contexts, it is found that it is only the first three levels that are deployed (Houghton, 2004).

Nonetheless, Houghton (2004) contends that "as teachers, we should strive to be engaging students at Level 4, which is the level where the focus is on how the student manages his/her learning" (p. 6). This is reinforced by Kolb and Kolb in their 2005 study on experiential learning, where the authors emphasize that students are taking control of their learning. However, it is also plausible that before students learn to function at Level 4, they need to have undergone the previous levels (Biggs & Tang, 2007). This contention is in keeping with the constructive alignment principle of Biggs and Tang (2007), who advocate that sequential and incremental approaches to learning are required. Nevertheless, Level 4 is recognized by Houghton (2004) as the desirable level for engineering students.

Houghton (2004) also states that a framework based on constructive alignment can enable the transition of students from previous levels to Level 4 and argues that constructive alignment encourages clarity in the design of the curriculum and transparency in the links between learning and assessment. "In a truly constructively aligned curriculum, deep learning is facilitated as the activities are designed for that purpose. This should improve the quality of learning and graduates in our profession"

(Houghton, 2004, p. 29). Clarity and alignment of learning objectives, activities, and assessment are expected to empower the students to take charge of their learning, and thus enable them to perform at Level 4.

The Biggs and Tang (2007) constructive alignment model is presented in Figure 2.1. The authors assert that the model can be used as a general framework for teaching and that it can be implemented in virtually any course at any level of college teaching.



Adapted from Biggs and Tang (2007, p. 59)

Figure 2.1. Constructive Alignment Model

The model gives a broad framework for developing learning both objectives supported by activities and suitable assessment tasks that can gauge their learning. This model can be adapted for any course, but according to Houghton (2004), it is considered relevant for engineering. Cropley and Sitnikova (2005) who investigated how constructive alignment may be used in engineering education, stress that an engineering instructor must not only explain the details of the curriculum objectives of a program of study, but he/she must also emphasize that learning in engineering is more than merely meeting those objectives. This outcome, according to the authors, may be achieved through Biggs and Tang's (2007) constructive alignment. In other words, the curriculum objectives must express the details of the knowledge to be gained by the students, and the teaching and learning activities must show what is to be done to achieve these

objectives. Finally, the assessment tasks must inform students how they need to demonstrate their level of understanding (Cropley & Sitnikova, 2005).

As the current study aims to construct a new model to ensure that Learning-By-Doing pedagogical approach is aligned with the objectives of imparting the 21st Century Skills for engineering students, Biggs and Tang's (2007) constructive alignment model is expected to provide direction and basis for this new model. According to Biggs and Tang (2007), the alignment process cannot proceed without first examining the underlying learning theories, and then adopting teaching methods that align with those assumptions. It is for this reason that the next section turns to an exploration of theories that inform the development of a Learning-By-Doing model.

2.3. Theoretical Underpinnings of Learning-By-Doing

Lewis and Williams (1994) suggest that the 20th Century has seen a move from formal, abstract education to one that is more experience-based. John Dewey is one of the most renowned advocates of experience-based education. According to Dewey (1938), education cannot be imparted in an abstract manner but needs to have a relationship to experiences. As such, students need to see education as a combination of 'having' (having contact and experience with events), and 'knowing' (interpreting that experience) According to Lewis and Williams (1994), from Dewey's viewpoint, a learning experience does not just happen; it is a planned event with meaning and with experiential learning, and the learners then reaffirm this meaning.

2.3.1. Experiential learning.

It can be seen that Dewey's approach to learning has 'action' or 'doing' at the core. Dewey's (1938) Learning-By-Doing pedagogical approach, therefore requires a direct interaction between the learners and the learning content or the event, and thus enables experiencing the phenomenon under study, and facilitates validation of the theory or the concept that was outlined in the learning objectives.

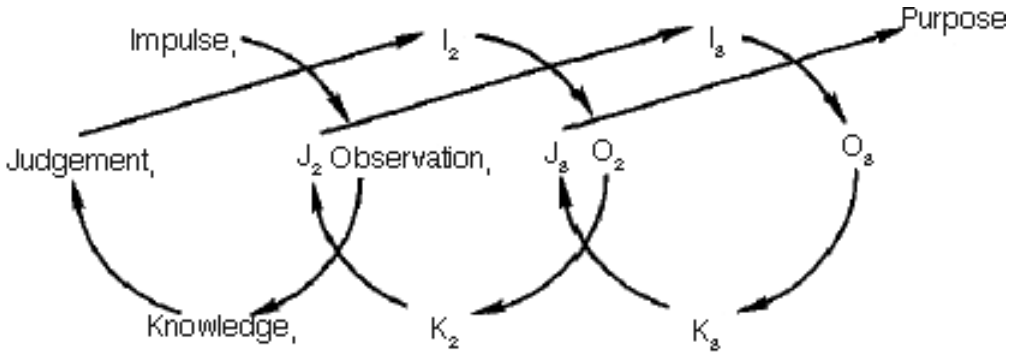


Figure 2.2. Dewey's Model of Experiential Learning (Kolb, 1984)

In Dewey's model, the emphasis is on learning as a "dialectic process integrating experience and concepts, observations, and actions. The impulse of experience gives ideas their moving force, and ideas give directions to impulse" (Kolb, 1984, p. 23).

Dewey's model of experiential learning is shown in Figure 2.2. He describes the developmental process of learning as:

> The formation of purposes is, then, a rather complex intellectual operation. It involves: (1) observation of surrounding conditions; (2) knowledge of what has happened in similar situations in the past, a knowledge obtained partly by recollection and partly from information, advice, and warning of those who have had wider experience; and (3) judgement, which puts together what is observed and what is recalled to see what they signify. A purpose differs from an original impulse and desires through its translation into a plan and method of action based upon foresight of the consequences of action under given observed conditions in a certain way. (Dewey, 1938, p. 69)

Dewey's (1938) ideas inform the work of other authors who suggest that ideas cannot be separate from experience; they must be connected to the learners' lives in order for learning to occur (Clark, Threeton, & Ewing, 2010; Kolb & Kolb, 2005; Lewis & Williams, 1994). The basic foundation of experimental learning, according to Dewey, is that learning is a process that is more about the journey and what it provides as opposed to the final destination being the goal. What this means is that while the final

destination is what is expected of the learning process, the how of getting there is what creates the environment for the best assimilation of learning 'how' and 'why' that final destination exists. It is not just the behavioral theory of one behaves a certain way in order to reach an anticipated goal, but also, includes the idealist theory of what is learned along the way and how this learned experience enhances or detracts from said anticipated goal. Learning, in essence, is a "continuous process grounded in experience" (Kolb, 1984, p. 26).

The learning process is "formed and re-formed through experience", which means that the 'how' of the learning process is imperative to the quality of the knowledge gained (Kolb, 1984, p. 27). This means that the process of learning needs to find a resolution to the conflict between the active process and reflective process of learning. The active process being the "naming" of the learning and the reflective process is the finding "meaning" in what the active process named (Kolb, 1984, p. 29).

Similarly, Biggs and Tang's (2007) constructive alignment espouses the need for students to be exposed to authentic learning experiences. Also, authentic learning is likened to establishing personal and real-world relevance (Kember et al., 2008). It is therefore important to provide students with teaching and learning materials, tasks, and experiences which are authentic and relevant (Kane, 2007; Meyers & Nulty, 2009). At the core of Learning-By-Doing is experiential learning, which includes reflective learning, active learning, cooperative, and collaborative learning (Meyers & Nulty, 2009).

Kolb's cycle of experiential learning is presented in Figure 2.3.

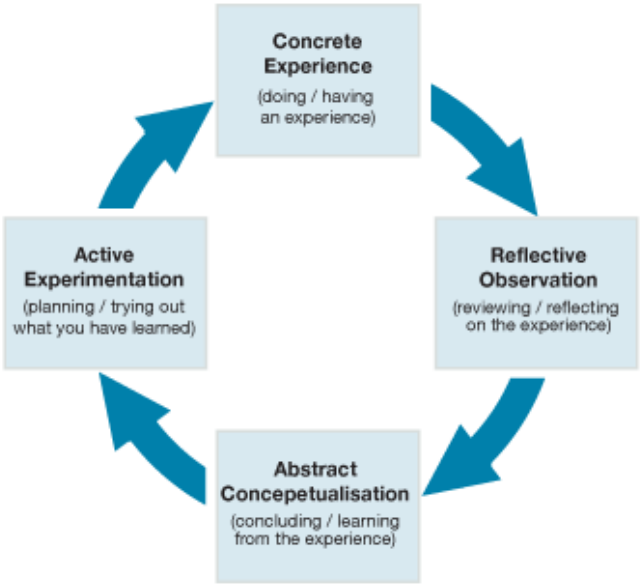


Figure 2.3. Kolb's Cycle of Experiential Learning (Kolb, 1984)

Furthermore, Kolb and Kolb (2005) identified four learning styles which correspond to these stages. The styles highlight conditions under which learners experience greater learning. These styles are:

- *Assimilators* are the people who learn better when presented with sound logical theories to consider.
- *Convergers* are those who learn better when provided with practical applications of concepts and theories.
- *Accommodators* are the students who get better results when they are allowed to have a hands-on experience while learning.
- *Diverges* learn better when allowed to observe and collect a wide range of information.

These styles are useful in different stages of the Kolb (1984) learning cycle and imply that the educators need to develop and elicit different styles in students during different stages of the learning cycle. Kolb's (1984) cycle of experiential learning is useful in the context of engineering students, as it aims to provide both hands-on

experience with learning content and give a chance to students to extrapolate and expand on their knowledge to apply to real life scenarios.

Other scholars have also added to the literature on experiential learning. Lewis and Williams (1994) put forward three distinct applications of experiential learning in higher education. These are field-based experiences, prior learning assessment, and experiential applications for personal development and classroom-based learning. Students can obtain field-based experiences through practical tasks or through industry internship that can give them first-hand experience of their future work. (Lewis & Williams, 1994). Also, a modified version of field-based experience can be created by allowing students to alternate periods of full-time employment and study (Lewis & Williams, 1994). Students can also engage in community service and learn and reflect from their experience (Ash & Clayton, 2004).

Experiential learning has been evaluated in the context of a mechanical engineering senior course (Pascual & Uribe, 2006), and this has highlighted that classroom-based experiential learning develops skills which are pertinent to new engineers in a professional environment. These include objective decision-making, team work, autonomous learning, conflict handling, and presentation and defense of initiatives. It also provides an appropriate environment for meaningful learning.

This discussion on experiential learning has indicated that experiential learning captured several other types of learning, either explicitly or implicitly. It can be asserted that experiential learning appears to have elements of reflective learning, active learning, and cooperative and collaborative learning. The following sections will, therefore, explore these approaches to learning in more detail, and the context of experiential learning

2.3.1.1. Reflective learning.

To Kolb (1984), any experience not reflected upon is unrealized learning. The stage of reflective observation in Kolb's cycle is essential because students reflect on their activity by collecting information to expand and to understand their experience;

they analyze their behavior, viewpoints, aims, feelings, and experiences. This need for reflection resonates with several researchers and is cited as a crucial factor in experiential learning (Ash & Clayton, 2004; Clark & Mayer, 2008; Clark et al., 2010; Morgado, 2010; Tamo, Jubani, & Gjokutaj, 2012). Ash and Clayton (2004), in their study of experiential learning in the context of service learning, however, point out the danger of having "poor quality reflection" (p. 139). Quality of reflection is expected to be maintained by the teachers or class facilitators, providing guidelines to encourage a more in-depth thought process among the students (Ash & Clayton, 2004).

In cases where students' learning may be "haphazard, accidental, and superficial" (Stanton, 1990, cited in Ash & Clayton, 2004, p. 185), very little actual learning or retention can take place. According to Stanton (cited in Ash & Clayton, 2004), reflection should involve three aspects: civic, personal, and academic. Also, Drew and Mackie (2011) urge the inclusion of the affective part of learning, such as the promotion of values in experiential learning.

2.3.1.2. Active learning.

According to Chickering and Gamson (1987, cited in Lewis & Williams, 1994), active learning is one of the seven underlying principles of attaining excellence in undergraduate learning. Activities that involve students in actively participating, and which motivate students to do rather than just listen, qualify as active learning practices (Chickering & Gamson, 1987, cited in Lewis & Williams, 1994). Such activities include enabling students to experiment with new roles and behaviors in classrooms, allowing them to experience real-life situations, and providing them with useful feedback, and encouraging them to relate theory to practice (Lewis & Williams, 1994).

Active learning schemes used in engineering courses have been widely proven to provide many benefits in the learning process (Pascual & Uribe, 2006). One of the most remarkable improvements in its efficiency is making engineering students conscious of learning (Pascual & Uribe, 2006; Romi, 2009).

Finkel (2013) also asserts in his report regarding innovative approaches to engineering education in Australia, cited that one of the country's best practices is learning strategies that prepare graduates for real-world engineering using the active learning approach, which he reports makes for faster and more effective learning.

2.3.1.3. Cooperative and collaborative learning.

According to Paulson and Faust, "cooperative learning covers the subset of active learning activities which students do as groups of three or more, rather than alone or in pairs" (Paulson & Faust, 2010, p. 1). On the other hand, collaborative learning refers to those classroom strategies which have the instructor and the students placed on an equal footing working together in; for example, designing assignments, choosing texts and presenting material to the class (Paulson & Faust, 2010). All these learning strategies can be incorporated in the engineering teaching method and hence, are essentially included in the literature review.

2.3.2. LBD in an engineering education context.

Learning-by-Doing through experiential learning is not a new trend to engineering education since core content subjects are usually taught hands-on (Vest, 2005). While LBD had its origin in the works of John Dewey (1938), it is of paramount relevance in present-day engineering educational contexts (Vest, 2005). Though the requirement of skills and mental aptitudes for the 21st Century may have undergone drastic changes, the LBD pedagogy is relevant for the acquisition of the skills that are critical for engineers in their jobs. The learning theories that underpin LBD, like experiential learning (active learning, cooperative learning, and collaborative learning), reflective learning and service learning – are expected to inform the teaching approaches taken by educators in institutes of higher technical education (Morgado, 2010). In addition, Biggs and Tang's (2007) instructional design and constructive alignment, aside from fully supporting LBD as it espouses experiential learning, has usefulness in engineering education (Cropley & Sitnikova, 2005; Houghton, 2004; Meyers & Nulty, 2009; Nightingale, Carew, & Fung, 2007). The differences between LBD in the 20th Century and present-day arise from the evolution of educational

technology that makes it possible for students to use Information and Communication Technologies to facilitate learning by doing (Vest, 2005). Also, there is a shift in the expectations of 21st Century engineers, in their skill sets and core professional competencies, which calls for adaptation of LBD curriculums to suit the current realities.

2.3.3. LBD elements based on an experiential learning approach.

As seen in the literature, Biggs and Tang's (2007) constructive alignment advocates experiential learning, and interrelations can be observed with LBD elements and Kolb's (1984) experiential model (Figure 2.3: Kolb's Cycle of Experiential Learning). Also, the review of the literature highlighted the following elements of LBD:

1. Learning to do (skills) not just to know (factual knowledge) (Clark et al., 2010; Kolb & Kolb, 2005; Lewis & Williams, 1994);
2. Learning that is experiential (Finkel, 2013; Kolb & Kolb, 2005), active (Chickering & Gamson, 1987, cited in Lewis & Williams, 1994; Pascual & Uribe, 2006), collaborative and cooperative (Paulson & Faust, 2010);
3. Learning that occurs in the context of a goal that is relevant, meaningful and interesting to the student (Kane, 2007; Kolb, 1984, cited in Healey & Jenkins, 2000);
4. Learning that is planned (not discovered) (Kolb, 1984, cited in Lewis & Williams, 1994)
5. Learning that involves not only quality academic reflection (Ash & Clayton, 2004; Clark & Mayer, 2008; Clark et al., 2010; Morgado, 2010; Tamo et al., 2012; but civic (global) and personal as well (Ash & Clayton, 2004; Drew & Mackie, 2011; Tamo, et al., 2012);
6. Learning that considers students' cultural context (Thanh, 2011), respects students' experience and builds on this (Kane, 2007; Kolb & Kolb, 2005);
7. Learning that involves practical experiences, and in the context of real-life scenarios that the students are expected to encounter in their futures

(Chickering & Gamson, 1987, cited in Lewis & Williams, 1994; Clark et al., 2010; Kolb & Kolb, 2005);

8. Learning that involves strategies such as presentation, reports, team building, on-line contact time with students, critical thinking, studio teaching, team projects, open-ended problem solving (Ash & Clayton, 2004; Chan, 2011; Morgado, 2010; Vest, 2005).

Although the literature review did not provide any specific definition of LBD, it links it to several essential elements that ultimately promote the LBD pedagogical philosophy. These elements are further captured in the form of 16 LBD practices that are later used in the quantitative strand of the research to gauge the participants understanding of how well LBD is being practiced at the selected institute.

1. Classroom activities that require students to collaborate and learn with and from each other (group projects that emphasize teamwork)
2. Discussions in the classroom that are interactive where students, as well as the teacher, contribute to the topic being discussed.
3. Question and answer that focuses on the post-evaluation of learning activities
4. Exam questions that are focused on scenarios that require students to apply what they have learned and not merely limited to ones that call for memorization
5. Use of real-life case studies by the teacher as a means for teaching the content of the course
6. Presenting problem-based questions to students where students, either in a group or as individuals work out the solutions
7. Use of simulation (digital or manual) by the teacher as a means of teaching a concept
8. Demonstration of a required subject skill by the teacher followed by the student.
9. Conduction of drills and practices for learning and mastering a skill or a concept.
10. Encouraging students to reflect on what they have learned and express this reflection either orally or in written format
11. Using multiple modes of assessment where the teacher uses other means in addition to his/her assessment (students' self-assessment or peer review)

12. Teachers conduct activities that allow students to experience the topic (field trips and workshops) fully
13. The college provides programs that bring students to the workplace as part of the students' preparation for professional working life after graduation
14. Classroom activities that ask the students to model experiences or concepts (role-playing or reenactment)
15. Teachers encourage students to record their impressions on how they did the project on a phase-by-phase basis (in addition to showing the required project output)
16. Classroom activities that are formulated in such a way that students can be more active and motivated in doing it (educational games and other hands-on activities)

2.3.4. Limitations and considerations for LBD.

It is acknowledged that the LBD model needs to be utilized with some considerations and limitations. For example, Kolb and Kolb's (2005) study concluded that experiential learning could be made more significant if it (1) respects learners and their experience, (2) builds on the learner's experience, and, (3) provides adequate support to learning. They recommended that educational institutions make space for conversational learning, acting and reflecting, feeling and thinking, inside-out learning, and letting learners take control of their learning. It can, therefore, be assumed that in the absence of such a facilitative environment, LBD implementation may meet with limited success. Additionally, activities involving presentation, reports, team building (Chan, 2011), online contact time with students (Morgado, 2010), critical thinking and problem-solving (Ash & Clayton, 2004) are all deemed necessary in experiential learning and should be taken into account in the development of a new LBD model.

Another consideration relates to the cultural differences that may become apparent when the Western concept of LBD is used in Asian contexts. Pham and Renshaw (2013) investigated the application of student-centered Western educational reforms to Asian countries, and underscored the need to respect and build on learners'

experiences. The authors concluded that to be successful, universities should adopt learning strategies that will work in harmony with cultural values rather than against them. Similarly, Pascual and Uribe (2006), mention that cultural specificity is also an issue when implementing innovative learning strategies like LBD. In their research aimed at enabling Asian teachers to empower students through student-centered approach, Pham and Renshaw (2013) argue that any educational reform practices imported and imposed on classrooms need to "take teachers' voices, especially their cultural beliefs in teaching and learning into consideration" (p. 67). The researchers contend that teaching and learning processes cannot be analyzed "in isolation from the values that are privileged in a culture" (Pham & Renshaw, 2013, p. 67). Although within a very different context and circumstances, Freire (1970, p. 34), too, asserted that "the goal of education is to raise the critical consciousness of learners using experiential encounters with the realities of their culture".

Several other scholars have expressed concerns regarding pedagogies that place the student at the center, for students who have Islamic backgrounds and have undergone Koranic learning (Ginsburg, 2009). This is because such students have been inculcated into rote-learning and memorization, with the teacher placed at the center of the learning process. The author also points out that Islamic scholarly tradition also implemented aspects of experiential learning and discourse-based learning, as evident from the texts by Islamic scholars and educators. As such, he contends that it is essential to keep the cultural background of the learners in focus before introducing them to student-centered, active, and experiential learning. There is, therefore, a need for gradual assimilation of the Western idea of student-centered learning to make it less imposed.

Conversely, Kane (2007), in studying active learning methodologies, concluded that it is not primarily cultural issues that affect the success of learning but the personal perception of the learners. He recommended that the educator custom-fit the activity to the learner to get the best results. Moreover, Kane stated that it is the responsibility of the educator to "mediate" between the learner and the method about cultural values/practices and the learning (Kane, 2007, p. 285). This customization of activity is to suit the learner and the role of the educator as the mediator between learner and

method is central to Clark and Mayer's (2008) position about the LBD pedagogical philosophy. While not discrediting the efficacy of LBD, Clark and Mayer (2008) state that instructional professionals must "create instructional environments that promote high levels of psychological activity congruent with the learning objectives" (p. 9) and not limit classroom activities only to the behavioral. They recommended that teachers should still focus on cognitive development and use appropriate activity, such as the traditional lecture method, to support it. For example, Revell and Wainwright (2009) support the use of lectures in combination with active learning as a potent strategy for classroom teaching. Revell and Wainwright (2009) based their contention on the findings from their study that captured perceptions of both students and teachers about lectures. Furthermore, Revell and Wainwright (2009) found that lectures were considered effective when they encouraged participation and engagement with students, and when they had a clear structure that could guide students toward crucial learning. Also, lectures that can facilitate links between different subjects and contexts relevant to the students are expected to encourage experiential and reflective learning. The authors, however, emphasized the role of the teacher is to encourage students to participate and to motivate them toward having a more in-depth understanding.

Similarly, Healey and Jenkins (2000) make a case for traditional teaching methods and suggest that educators should build upon their traditional approach with elements from Kolb and Kolb's (2005) learning cycle, rather than rejecting their traditional teaching methods altogether. Likewise, Kane (2007) states that the lecture method still has its place in a teaching and learning methodology, but also suggests that teachers encourage discussion and reflection, which emphasizes critical thinking. A similar recommendation was made by Hung and Lee (2012), who, in exploring 21st Century teaching in a university in Singapore, concluded that a traditional type of learning or the so-called "objectivist" type, still has a place in the modern classroom, and that "learning by heart" (Hung & Lee, 2012, p. 465) which includes the so-called low-level learning methods is still important. In the same way, Vest (2005), President Emeritus of Massachusetts Institute of Technology and President of the US-based National Academy of Engineering, in talking about engineering education for 2020 and

beyond, stated that "well-delivered lectures are wonderful teaching and learning experiences … that still have their place in engineering education" (p. 166). The authors also stressed that studio teaching, team projects, open-ended problem solving, and experiential learning, among others, should be integral elements of engineering education.

Briefly, the preceding discussion has highlighted several considerations that should be considered before developing and implementing an LBD approach to teaching and learning. The role of traditional methods and techniques needs to be retained, probably in some modified format, while cultural sensitivities and culture-based orientations toward learning also need to be addressed before successful implementation of any LBD curriculum. Section 2.3 has discussed the theoretical underpinnings of LBD and elaborated upon the suggested LBD model, addressing several considerations related to LBD implementation. It is suggested that LBD is an approach to teaching or a guideline about how teachers can enhance learning in the classroom by encouraging 'doing' or active engagement and experience. LBD does not inform the 'what', or what the students need to learn or which skills they need to learn. In the 21st Century, there is a massive thrust toward the acquisition of specific and targeted skills that resonate not only with the modern day workplaces, but also ensure that people have an ethical orientation and cultural sensitivities. The next section presents a discussion of such skills and explores various frameworks that have already been developed to support the teaching of these skills.

2.4. 21st Century Skills

There is increasing recognition of the new skills needed in 21st Century workplaces, skills that go beyond 20th Century Skills such as the ability to memorize, basic literacy, and ability to apply knowledge in a limited capacity (Kay, 2010). There has been a focus on evolving relevant skill sets around which teaching can be delivered. According (Kay, 2010) to provide education that is relevant and globally competitive, the skills needed for the 21st Century should be incorporated into planned learning

outcomes; not only as unplanned and accidental consequences of lessons but as designed, systematic results of lessons, which are then eventually assessed. Against the backdrop of this identified need, several institutions have put forward frameworks for enumerating diverse 21st Century Skills, and guidelines for educators to include them in their curricula. This section summarizes seven of the better known frameworks and presents comparisons to identify common and unique skills among them. It also aims to inform the development of a set of 21st Century Skills, which may be included in the proposed LBD model.

2.4.1. 21st Century Skills Frameworks.

2.4.1.1. Partnership for 21st Century Skills Framework.

The Partnership for 21st Century Skills Framework (2006), known as P21 Framework, from the USA, mentions that several significant and emerging content areas are critical to success in communities and workplaces. These content areas typically are not emphasized in schools today: global awareness; financial, economic, business, and entrepreneurial literacy; civic literacy; along with health and wellness awareness. It is further argued that while students need to learn academic content, they also need to know how to continue learning and make effective and innovative use of what they know throughout their lives. Thus, P21 identified learning and thinking skills, which should be incorporated in all subjects: critical-thinking and problem-solving skills; communication skills; creativity and innovation skills; collaboration skills; contextual learning skills; and finally, information and media literacy skills. While teachers may already incorporate life skills into their pedagogy, the P21 Framework contends that the current challenge is to incorporate essential life skills into schools deliberately, strategically, and broadly. These skills include leadership, ethical orientation, accountability, adaptability, personal productivity, personal responsibility, people skills, self-direction, and social responsibility.

With regard to assessment, the P21 Framework is premised on the belief that assessment instruments must measure the five results that matter: core subjects; 21st Century content; learning and thinking skills; ICT literacy; and life skills. To be

effective, sustainable, and affordable, assessment instruments must use modern technologies to increase efficiency and timeliness. Standardized tests alone, according to the Framework, can measure only a few of the important skills and knowledge students should learn. A balance of assessments, including high-quality standardized testing along with effective classroom assessments, which offers students and teachers a powerful tool to master the content and skills, are central to success.

2.4.1.2. The EnGauge Framework from Metiri and NCREL.

The EnGauge Framework from Metiri and NCREL (2003) focuses on four key skills and several sub-skills. The most important of all key skills, according to this framework, is digital-age literacy, under which are basic, scientific, economic, and technological literacies; visual and information literacies, and multicultural literacy and global awareness.

Inventive thinking, the second of the key skills, includes adaptability, managing complexity and self-direction; curiosity, creativity and risk-taking, along with higher-order thinking and sound reasoning skills. Effective communication is the third important skill, and its sub-skills cover teaming, collaboration and interpersonal skills; personal, social and civic responsibility, and interactive communication. Finally, high productivity, the last of the four key skills, includes prioritizing, planning, and managing for results; effective use of real-world tools, and the ability to produce relevant, high-quality products as sub-skills.

2.4.1.3. The Organization for Economic Cooperation and Development (OECD) Framework.

The OECD Framework (2005) presents a concept of 21st Century Skills, which includes three broad competencies: using tools interactively, interacting in heterogeneous groups, and acting autonomously. These categories, each with a specific focus, are interrelated. Reflectiveness or the ability to think and act reflectively forms the crux of the framework. Developing reflectiveness in individuals is expected to equip them with the ability to manage and adapt to change, to draw lessons from experience,

and to cultivate a critical thinking approach. Some of the competencies enumerated by this framework include – the ability to use verbal and oral language; ability to manage conflicts; and ability to act autonomously. Also, skills like developing life plans and the ability to have an understanding of needs, rights, limits, and interests are also included. The OECD framework claims to provide competencies that can be developed and assessed in a school-based environment as well as in adult learning (OECD, 2005).

2.4.1.4. The American Association of College and Universities (AACU) Framework.

The American Association of Colleges and Universities Framework (2007) was specifically developed for college-level learning. It is premised on the understanding that technology and globalization have reshaped the world in the 21st Century, requiring new skills including understanding diverse cultures, appreciation of the natural and physical world, having intellectual skills, being pragmatic, exhibiting responsibility in a personal capacity, being socially responsible, and having the ability to have integrative learning to link concepts and experiences.

2.4.1.5. The Center for Public Education's (CPE) Framework.

The CPE Framework (2009), too, evolved on the premise that the 21st Century poses different challenges and presents diverse opportunities – which cannot be met with 20th Century Skills. According to this framework, automation technology has replaced unskilled, routine tasks in the second half of the 20th Century, but in more recent times, artificial intelligence and machine learning technologies are gearing to take on thinking and complex tasks as well. As such, the focus for human capacity development in the 21st Century needs to be on acquiring skills enabling complex communications, expert level thinking, and decision-making. The CPE framework, therefore, puts forward three broad areas of relevance in the 21st Century – basic knowledge of core subject areas; literacy or ability to apply academic learning to real-life situations; and the competence to draw upon this basic subject knowledge and literacy to enhance personal and professional well-being.

2.4.1.6. The European Union Framework.

The European Union Framework (2006) sets out eight key competencies or skills for the 21st Century. These are as follows:

1. Communication in the mother tongue;
2. Communication in foreign languages;
3. Mathematical competence and basic competences in science and technology;
4. Digital competence;
5. Learning to learn;
6. Social and civic competences;
7. Sense of initiative and entrepreneurship;
8. Cultural awareness and expression.

The framework further explains that these key competencies are all considered equally important because each of them can contribute to a successful life in a knowledge society. Many of the competencies overlap and interlock; aspects essential to one domain will support competence in another. Besides, the EU framework argues that competence in the fundamental basic skills of language, literacy, numeracy, and information and communication technologies (ICT) is an essential foundation for learning. There are several themes that are applied throughout the EU framework: critical thinking, creativity, initiative, problem-solving, risk assessment, decision-making, and constructive management of feelings which plays a role in all eight key competencies.

2.4.1.7. The International Society for Technology in Education (ITSE).

In 2007, The ISTE Framework revised its student standards for technology in the curriculum. These standards include creativity and innovation, wherein students demonstrate creative thinking and construct knowledge and develop innovative products and processes using technology. Communication and collaboration are seen in the student's use of digital media and environments to communicate and work

collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Another standard is research and information fluency, wherein students apply digital tools to gather, evaluate, and use information. Critical thinking, problem-solving and decision-making are also stressed, but from an ICT viewpoint, where students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Digital citizenship, according to the ISTE framework, is present when students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. As a final point, technology operations, and concepts are given focus as the last of the set standards where students demonstrate a sound understanding of technology concepts, systems, and operations.

2.4.1.8. Summary.

Section 2.4.1 has discussed 21st Century education and its associated teaching-learning frameworks. It has established that there is substantial overlap in the skills expounded by different frameworks. The following section compares these frameworks in order to evolve a list of 21st Century Skills.

2.4.2. Comparing 21st Century Skills Frameworks.

In comparing the frameworks, the researcher relied on the analysis of three different authors: Dede (2010), Mishra and Kereluik (2011), and Voogt and Roblin (2010), all of whom have compared the similarities and differences of 21st Century Skills frameworks.

Dede (2010) used the Partnership for the 21st Century Skills Framework (P21) as a baseline. He compared and contrasted four 21st Century frameworks. As previously indicated, the Partnership for 21st Century Skills Framework (2006), espouses the following: global awareness; financial, economic, business, and entrepreneurial literacy; civic literacy, and; health and wellness awareness. P21 also identifies learning and thinking skills needing to be incorporated in all subjects: critical-thinking and problem-

solving skills; communication skills; creativity and innovation skills; collaboration skills; contextual learning skills, and finally; information and media literacy skills.

A summary of Dede's (2010) comparison of 21st Century frameworks is presented in Table 2.1

Table 2.1

Summary of Dede's (2010) Comparison of 21st Century Frameworks

Framework	Skills not present in P21 the framework
Metiri Group and NCREL (2003)	▪ Visual literacy ▪ Curiosity and risk taking ▪ Managing complexity ▪ Prioritizing, planning and managing for results ▪ Multicultural literacy
Organization for Economic Cooperation and Development (OECD) (2005)	▪ Using language, symbols and texts ▪ Managing and resolving conflicts ▪ Acting autonomously ▪ Life plans ▪ Defending and asserting rights
American Association of Colleges and Universities (AACU) (2007)	▪ Knowledge of human cultures ▪ Inquiry and quantitative analysis
International Society for Technology in Education (ISTE) (2007)	▪ Creating original works as a means of personal or group expression ▪ Using models and simulations to explore complex systems and issues ▪ Identifying trends and forecasting possibilities ▪ Safe, legal use of information and technology ▪ Digital citizenship

Dede (2010) noted that in the Metiri Group and NCREL (2003) framework and the OECD (2005) framework, more emphasis is placed on new contextual skills and knowledge. He also stated that in the American Association of Colleges and Universities (AACU) (2007), more emphasis is placed on action or doing and not just information receiving and memorizing. Additionally, he observed, the digital literacies in the International Society for Technology in Education (ISTE) (2007) framework are more

detailed than in other frameworks. It is noted that ISTE's focus on ICT is echoed in work done by several researchers and in organizational studies (Cisco-Intel-Microsoft, n.d.; Punie, Zinnbauer, & Cabrera, 2006).

In summary, Dede (2010) stressed the similarities between the various frameworks and also pointed out that different frameworks appeared to be building on each other's conceptions.

In their turn, Mishra and Kereluik (2011) reviewed ten frameworks of 21st Century learning. Their analysis also included works of Howard Gardner, Yong Zhao, and Daniel Pink (Mishra & Kereluik, 2011). Like Dede (2010), they identified similarities and differences between these ten frameworks. However, unlike Dede, they dissected each framework into individual elements to see what broader themes cut across them. This dissection of individual frameworks enabled Mishra and Kereluik to perceive broad themes that they used to develop their analysis which resulted in the evolution of three broad categories of skills, namely, foundational knowledge, meta-knowledge, and humanistic knowledge. According to the authors, foundational knowledge is the answer to the "What do students need to know?" question. Based on the frameworks reviewed, they saw this in terms of three key sub-categories: core content knowledge, information literacy, and cross-disciplinary knowledge/synthetic knowledge. For Michra and Kereluik (2011) meta-knowledge is about knowledge of how to work with foundational knowledge. Although differing in terminologies, meta-knowledge in the different 21st Century frameworks could be seen, according to the authors, in terms of three sub-categories: problem-solving/critical thinking; communication/collaboration, and; creativity/innovation.

Finally, the third key sub-category, humanistic knowledge is knowledge about the learners' context, as defined by his or her geo-cultural background, as well as social and global context. In the different 21st Century frameworks, according to the authors, these can be categorized as life/job skills, cultural competence, and ethical/emotional awareness.

In 2013, Kereluik, Mishra, Fahnoe, and Terry expanded the 2011 review of Mishra and Kereluik to include five more 21st Century frameworks, making a total of 15. However, the researchers arrived at similar results as found in the original (2011) review. Figure 2.4 shows a synthesis of the 2013 analysis.

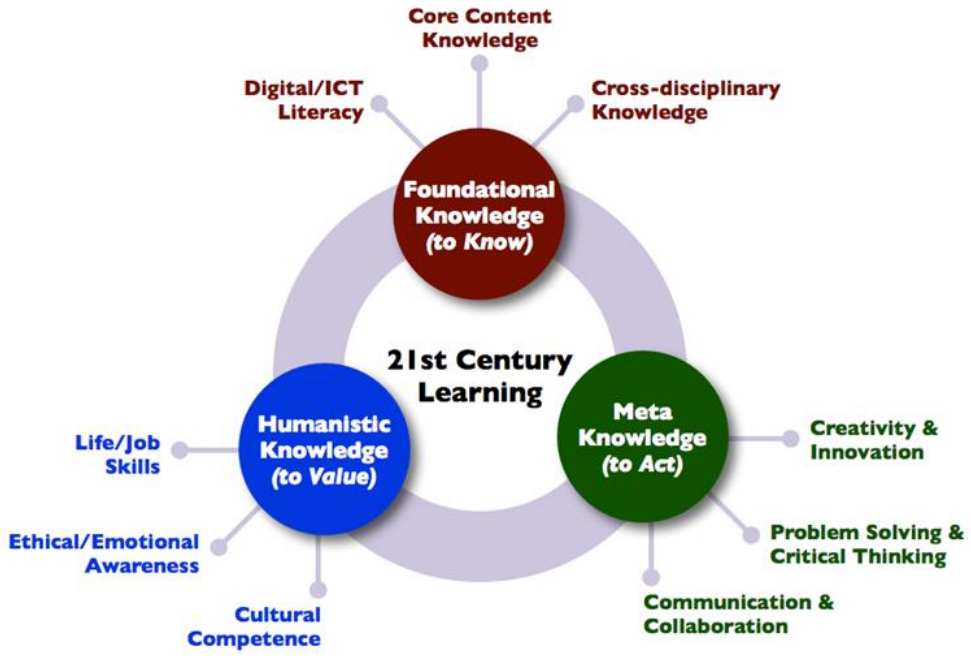


Figure 2.4. Synthesis of 21st Century Learning Frameworks (Kereluik et al., 2013)

2.4.3. 21st Century Skills in the engineering context.

In 2004, an investigation by Wolfe revealed that, according to MIT mechanical engineering alumni, engineering science was not as useful in their careers as design, communication, teamwork, and entrepreneurial thinking. They reported that these professional skills were mostly learned during their career as engineers but were seldom if at all, taught during their undergraduate studies. The most significant disconnects, according to Wolfe (2004), were in the areas of personal skills, professional skills, independent thinking, teamwork, and communication. These skills are similar to those advocated by Vest (2005) as being important to engineering education for 2020 and beyond.

The global survey of engineering students conducted by US-based National Academy of Engineering (NAE) (2010) revealed that to answer today's challenges, an attitude rather than aptitude is necessary. Based on the initial findings, the students' capacity to apply knowledge in practice by learning to adapt to new situations, critical and self-critical abilities, and teamwork and communication skills rank as the top three competencies needed by 21st Century engineers.

Similarly, Morell (2010), in reviewing the roles, opportunities, and challenges of engineering education in the 21st Century, contends that the new professional engineer not only needs to be knowledgeable in his/her discipline but also needs a new set of soft, professional skills and competencies. More importantly, he argues that engineering educators need to integrate diverse classroom techniques, like cooperative learning, active learning, experiential learning, and reflection.

An on-going longitudinal study by Iowa State University (2008) has attempted to assess and disseminate a comprehensive model to integrate communication, ethics, leadership, economics, and creativity into an undergraduate engineering curriculum. Equally important and included in their concept of leadership is teamwork. Additionally, Hung and Lee (2012), in their study of a Singaporean higher learning institution conclude that in the 21st Century, 'attitude, skills, and knowledge' are no longer sufficient but soft skills such as leadership, adaptability, resilience, collaboration, sociability, and risk-taking should be incorporated in the curriculum.

Moreover, the changing economy makes it more of a necessity that students can use technology to solve problems, collaborate, and create. In today's world, critical thinking, problem-solving, and reflection skills form the crux of desirable job and life skills (OECD, 2015; Saavedra & Opfer, 2012).

2.4.4. 21st Century Skill set for current study.

The literature reviewed leaves no doubt as to the importance of 21st Century Skills in today's education, particularly to engineering education. The work of researchers like Dede (2010), and Mishra and Kereluik (2011) has also revealed that

foundation knowledge taught through content engineering courses needs to be complemented by 21st Century Skills. The researcher adopts Mishra and Kereluik (2011) re-categorization of 21st Century Skills as the basis, on which additional skills are added from the literature focused on 21st Century Skills for engineering, to develop a comprehensive skill set for 21st Century Skills. Mishra and Kereluik (2011) re-categorization entails that the skills are divided into three categories – foundational knowledge, meta-knowledge, and humanistic knowledge development. In the context of the current study, foundational knowledge relevant skill is limited to digital literacy, as this is the only foundational skill mentioned by most frameworks reviewed by Mishra and Kereluik (2011), the other two (core content knowledge and cross-disciplinary knowledge), is explicitly mentioned only in P21 Framework. Other skills categorized under meta-knowledge and humanistic knowledge have been repeatedly found in the majority of 21st Century Skills frameworks, and have been mentioned by scholars like Wolfe (2004), Vest (2005), Pascual and Uribe (2006) and Morell (2010).

1. Foundational Knowledge
    a. Core content knowledge
    b. Cross-Disciplinary Knowledge
    c. Digital/ICT literacy (Morell, 2010; Pascual & Uribe, 2006; Vest, 2005)
2. Meta-knowledge
    a. Critical and self-critical abilities/problem solving (Morell 2010; NAE, 2010; Vest, 2005)
    b. Communication and collaboration (Iowa State University, 2008; Morell, 2010; NAE, 2010; Vest, 2005; Wolfe, 2004)
    c. Teamwork (Morell, 2010; NAE, 2010; Pascual & Uribe, 2006; Vest, 2005; Wolfe, 2004)
    d. Creativity/innovation (Iowa State University, 2008; Vest, 2005)
3. Humanistic knowledge
    a. Life and job skills (NAE, 2010; Vest, 2005; Wolfe, 2004)
    b. Ethics and cultural knowledge (Iowa State University, 2008; Vest, 2005)

This led to the extraction of *eleven* core 21st Century Skills that were later used in the current study.

1. Creativity
2. Communication
3. Collaboration
4. Teamwork
5. Critical Thinking
6. Cultural Sensitivity
7. Ethical orientation
8. Life Skills
9. Problem Solving
10. Innovation
11. Computer literacy

2.5. LBD and 21st Century Skills

2.5.1. Mapping LBD with 21st Century Skills.

The previous sections have led to the development of LBD elements that supported LBD practices and synthesis of eleven 21st Century Skills from the work of diverse scholars. Based on the synthesis presented in the previous sections, the demarcation between LBD and 21st Century Skills appears to overlap in many places. It can also be observed that several 21st Century Skills appear to take their roots from Dewey's (1938) work, among others. The following table presents the alignment between LBD elements and 21st Century Skills necessary in engineering education.

Table 2.2

Alignment of LBD Elements and C21st Skills

	LBD Practices	C21st Skills
1.	Learning to do (skills) not just to know (factual knowledge); experiential, active, cooperative, collaborative learning	creativity/innovation life & job skills/communication & collal teamwork
2.	Learning that occurs in the context of a goal that is relevant, meaningful, and interesting to the student	life & job skills communication critical & self-critical abilities/problem-solving
3.	Learning that is planned	all skills should be planned learning outcomes
4.	Learning that involves quality reflection	critical & self-critical abilities ethical behavior & cultural knowledge
5.	Learning that considers culture	ethical behavior & cultural knowledge
6.	Learning that involves practical experiences in the context of relevant tasks closely related to how students will use it outside the learning environment	creativity/innovation life & job skills communication & collaboration teamwork
7.	Learning that involves strategies such as presentation, reports, team building, on-line student contact critical thinking, studio teaching, team projects, problem solving	communication & collaboration teamwork critical & self-critical abilities

2.5.2. Assessment and evaluation issues for LBD and 21st Century Skills.

As seen from the reviewed literature, what is learned and how it is taught must be transformed to respond to the social and economic needs of students and society as we face the challenges of the 21st Century. It can, therefore, be gleaned from the existing literature that education reform is needed in curriculum, pedagogy, and assessment.

Cisco-Intel-Microsoft (n.d.) stressed that reform is particularly needed in education assessment. In their call-to-action for assessment reforms, this group of IT

companies stated that ICT-based assessments could be used to assess higher-end learning, including collaboration, problem-solving, and critical thinking. Admittedly, the organization conceded that not all assessment reforms require the use of ICT; however, they argue that technology provides some significant advantages when introduced into the assessment. Similarly, Voogt and Roblin (2010) have proposed the use of technology for assessment – either by converting traditional assessment forms to digital format or developing new technology-enabled assessment techniques.

In addition to deployment of technology, it is proposed that some assessment of 21st Century Skills be done through observation, self-report assessment, or some standardized assessment tests developed through psychometric modeling (Lai &Viering, 2012). However, some difficulties are encountered in assessing the acquisition of 21st Century Skills. For example, Lai and Viering (2012) state that individual 21st Century Skills are correlated with each other in intricate ways that make their independent assessment difficult. Nevertheless, Lai and Viering (2012) propose using a triangulation approach where multiple measures can be used. They further propose effective assessment of skills, including development of tasks that are not finely-structured and are open to interpretation (thus making an assessment of skills like innovativeness and creativity possible); designing complex and challenging tasks that can test problem solving or critical thinking skills; or using assessment tasks that present the students with real-life problems. Similarly, the P21 Framework provides more explicit guidance about developing instruments for both summative and formative assessment. Some of the summative assessment techniques include tests, essays, or presentations, while formative assessment includes portfolios, systematic observation of learning, and self or peer assessment.

While there is considerable literature on the different types of mode of assessments to be used for 21st Century Skills assessment, there appears to be a consensus on the fact that the nature or end objective of assessment should be 'assessment for learning' or for improving the quality of learning, rather than 'assessment of learning'. This shift is essential as it guides the development of

assessment practices that ensure that what is assessed is aligned with what was intended to be learned (Voogt & Roblin, 2010) This alignment is already highlighted in Biggs and Tang's (2007) constructive alignment model (Figure 1). The learning objectives must be aligned, not only with the teaching/learning activities but more importantly, with assessment (Biggs & Tang, 2007; Cropley & Sitnikova, 2005; Houghton, 2004). Nightingale, Carew, and Fung (2007) posit that assessment methods that match learning objectives are a key to encouraging student engagement, as most students will strongly tailor their learning to suit the structure of the assessments and gain maximum marks. They warn that if the assessment tasks do not match the objectives, students can start to lose trust in the teacher and the system, and may revert to strategic surface learning instead of deep learning.

In explaining how constructive alignment may be adopted in engineering education, Houghton (2004) proposes two approaches to assessment – a traditional approach based on giving correct answers to questions based on course content and a second approach that evaluates students achievement of learning outcomes. The traditional approach is limited by the fact that it does not encourage holistic learning as students can gain marks disparately without really understanding the lesson entirely. Houghton (2004) therefore suggested Biggs and Tang (2007) approach – the use of criterion-based tests based or rubrics - what 21st Century frameworks call global rating scales. A similar criterion-based assessment approach is suggested by Nightingale et al. (2007). Also, Voogt and Roblin's recommendation that while summative and formative assessments are useful in assessing 21st Century Skills, new forms of assessment should build on previous assessment practices and should be considered.

Nightingale et al. (2007) investigated the use of constructive alignment in assessing engineering education and recommended using taxonomies as a basis not only for writing intended learning outcomes but also measuring learning, thus the alignment, which Biggs and Tang (2007) advocate, is present. Voogt and Roblin (2010) recommend that schools intending to adopt 21st Century Skills into their curriculum should provide specific operational definitions. Such definitions of the competencies are

expected to give clarity to students on what they are required to acquire, and it is also expected to help in developing the focused assessment.

2.6. Summary

This chapter presented a review and synthesis of the current LBD practices and 21st Century frameworks. This review prompted the development of a list of practices about LBD and 21st Century Skills that are later incorporated in the research questionnaires used in this study. The chapter also presented a brief overview of the LBD approach practiced in the context of the target institute. All of this provided a firm foundation from which the researcher was able to create a conceptual framework used in the development and analysis of the primary research findings of this study. The research studies incorporated in this literature review helped the researcher choose a methodology of the study, as seen in the following chapter, which led to the designated mixed methods study approach taken to satisfy the research objective as outlined in the introductory chapter.

CHAPTER 3: METHODOLOGY

3.1. Introduction

Details of the research design and methodology are presented in this chapter. The techniques adopted, the rationale for the approach taken, and the methods of data collection used to address and satisfy the research objectives are outlined. There is a focus on how mixed methods research has been understood, including a definition and historical overview. A rationale for the adoption of a mixed methods approach is provided. A discussion of the mixed methods design typology, data collection techniques, data analysis procedures, reliability and validity of the quantitative data phase, as well as trustworthiness and reliability of the qualitative data phase, are discussed, and finally, ethical issues are addressed.

3.2. Research Questions

The overarching research question for this study is:

> *What constructively aligned Learning-By-Doing (LBD) pedagogical model, incorporating 21st Century Skills, can be developed for enhancing the teaching of engineering at HCT, UAE?*

The following research sub-questions were formulated to guide the study further:

Research Sub-Question # 1: What are the current understandings of LBD from the viewpoint of the dean of engineering and the instructors?

This research question sought to provide insights into the current understanding of LBD and its practice at the institute. It was essential to ascertain the basic knowledge of LBD as perceived by those involved in the practical implementation of its curriculum, and those involved in its practical delivery in the classrooms. Since the main research question is: "*What constructively aligned Learning-By-Doing (LBD) pedagogical model, incorporating 21st Century Skills can be developed for enhancing the teaching of engineering in the HCT, UAE*", it is essential to explore and evaluate how LBD is currently being practiced. Consequently, the investigation could subsequently help in

evolving shared meaning of the construct and provide a source of a better understanding of professional practice (Bridges, 2003).

Research Sub-Question # 2: From the perspective of instructors and students, which LBD practices have successfully been implemented in the engineering division?

Research Sub-Question # 3: From the perspective of instructors and students, what 21st-Century Skills are taught, and assessed in the practice of LBD?

These questions aim to explore the implementation of an engineering curriculum through the pedagogical approach of LBD as per principles and best practices cited in the LBD literature already discussed. Using the insights from students, instructors, engineering dean, and findings from the empirical research, a final LBD model is developed.

3.3. Research Paradigm used in the Study

A research paradigm is underpinned by an underlying belief system that is used to guide the study (Guba & Lincoln, 1994). It can be presumed to be the researchers' worldview that gives direction to the research (Guba & Lincoln, 1994). According to MacNaughton and Rolfe (2001), a research paradigm has three characteristics. These include a basic belief or understanding of what constitutes knowledge, a basic assumption about what methodology can lead to knowledge acquisition, and an understanding of what comprises the criteria for validity. Willis, Jost, and Nilakanta (2007) elucidate that a paradigm is more like a conviction framework, which gives the researcher a perspective about the world and helps in developing suitable methodologies for data collection. Guba and Lincoln (1994) provide a more detailed understanding stating that a paradigm provides an ontology or a set of beliefs which determines how the researcher thinks that reality is constructed. Additionally, a paradigm includes epistemology, which determines the assumptions about the connections between the

researcher and the knowledge. Both ontology and epistemology guide the development of appropriate data collection methods

Four different world-views or paradigms, widely discussed in the literature are post-positivism, interpretivism, transformative, and pragmatism (Creswell, 2009), three of which are pertinent to this study. Table 3.1 provides an overview of these three paradigms. This was undertaken to make an informed decision regarding the selection of the most suitable paradigm to adopt for the current study.

Table 3.1

Research Paradigms

Characteristic	**Post-Positivist View**	**Interpretivist (Constructivist) View**	**Pragmatic view**
Purpose	The researcher predicts and explains the responses from the research participants	The researcher's role is restricted to recognizing and assessing individual responses in depth, and providing the perspective of the respondents	The researcher conducts interviews to acknowledge their experiences.
Beliefs	There is only one truth that needs to be found.	There are more than one truths and realities — different perceptions, needs, and experiences.	Using more than one method can reduce bias in research methodology.
Research Methods	Quantitative	Qualitative	Mixed Methods
What Study Data is Based Upon	Survey Collects information that can be analyzed statistically	Interview discussion that includes descriptive data and contextual information.	Convergent parallel design, open questions and close ended questions.

(Adapted from Snape & Spencer, 2003)

The post-positivistic approach, starts with claims and refines or abandons them during the testing period, and as such, is adequately supported by quantitative methodology (Creswell, 2009). Quantitative methods allow the data and evidence to be collected in objective and quantitatively measurable formats, thus enabling the study

findings to remain non-contextual and objective (Creswell, 2009). Therefore a quantitative approach was employed in the current study to gather data from the students which are amenable to numerical interpretation and which could lead to statistically significant insights.

Conversely, the qualitative methodology shares its worldview with the interpretivist paradigm and conforms to the view that there is more than one truth and more than one reality (Berg, 2012). Such a paradigm provides a holistic account of the perspectives of the research participants, in a contextualized manner and with the assumptions that people's experiences and contextual and cultural sensitivities should inform the research findings (Snape & Spencer, 2003). Thus, as Walsham (1993) asserts, an interpretive paradigm starts from a basic premise of a tentative reality, and then adds and includes the domain of social construction by human actors. In the current study, a qualitative methodology was also incorporated into the research design to ensure that the respondents' social and personal experiences were explored and a deeper understanding of the participants'' perspectives could be gained.

This research, therefore, adopted a pragmatic approach and combined the two methods – the post-positivistic paradigm led the quantitative method, and the interpretive paradigm led the qualitative method. A pragmatic approach that supports the use of a mixed methodology was found useful for the current study as the study aimed to focus on two different participants groups, the dean of engineering, the instructors, and the students, and to develop a holistic understanding of how the instructors delivered LBD and the 21st Century Skills learned by the students. A mixed methodology was found appropriate as it was deemed suitable to collect more contextual and in-depth data from the instructors and the dean, which warranted a qualitative data collection approach; and a more objective set of data from the students that could gauge their perceptions about how they were taught and assessed on LBD and the 21st Century Skills. A pragmatic paradigm is, therefore, most suited in this case as it allows the researcher to focus on the research problem and to develop pluralistic methods to arrive at a resolution (Patton, 1999; Teddlie & Tashakkori, 2009).

According to Creswell (2007), a pragmatic approach also allows the researchers to keep their focus on the outcomes of their research – what actions or situations or consequences of the research may occur – rather than on the antecedent conditions of the research. This too is found to be most suited in the current research context, where the outcome of the research is paramount, in the form of "what is the most suitable model that can enable greater implementation of LBD and 21st Century Skills". A pragmatic paradigm therefore not only provides a world-view and epistemological underpinnings for 'what data should be collected', and 'how it should be collected', but also goes further to inform 'what will be done with the research findings' (Teddlie & Tashakkori, 2009). With this paradigm, the nature of knowledge is that it needs to be obtained from diverse sources to render it meaningful, and as such, a mixed methodology approach is found to be adequate (Best, 2012; Creswell, 2007).

3.4. Mixed Methods Research

3.4.1. A historical overview.

Mixed methods research allows for the inclusion of multiple points of views and typically uses both qualitative and quantitative methods (Johnson, Onwuegbuzie, & Turner, 2007). Mixed method approach was evident in Psychology during the early 1950s and has gone several transitional phases (Creswell, 2009). More specifically, five-time periods can be identified in the history of mixed method research (Creswell & Plano Clark, 2011).

- The 1950s to 1980s – This was the formative period where multiple forms of data started to be considered
- The 1970s to 1980s – This period was determined by an intense debate on research paradigms and the utility of integration of different philosophical perspectives in mixed methods research had been discussed;
- The 1980s to 2000s – This can be called as the procedural development period, during with more experimental approaches were deployed, and authors tried to enrich their understanding of mixed research methods;

- 2000 to 2010 – During this period, there was further advocacy and expansion of mixed methods, and they began to be used in diverse disciplines
- 2008 onwards – This was the reflective period in which authors discussed controversies and issues surrounding mixed methods study

Several definitions of mixed methods research have emerged. These have incorporated various elements of philosophy, research design, research process, and methods. According to Greene, Caracelli, and Graham (1989), a mixed-methods design should include at least one quantitative and one qualitative data collection method, but neither methods need to be linked with a specific paradigm. In the same way, Teddlie and Tashakkori (2009) defined mixed methods research as one using both qualitative and quantitative approaches. Johnson, Onwuegbuzie, and Turner (2007) have further expanded on the practical understanding of the mixed method, by postulating that mixed method research uses a combination of qualitative and quantitative approaches for data collection, analysis, and interpretation. This understanding aligns with the approach taken in this study and supports the researcher's philosophical orientation underpinning the pragmatic research design employed in the current study.

3.4.2. Rationale for the use of mixed methods in this study.

A mixed method approach was selected as the best-suited method for this study, keeping in view the pragmatic stance that underpins the belief that multiple sources of knowledge are relevant owing to the dynamic and complex nature of individual human experiences. Also, since the pragmatic paradigm also indicates that knowledge and understanding of knowledge are best developed as a negotiated outcome between all the parties concerned, the current study employed a mixed method approach to collect, collate and merge data, to capture the perspectives of the dean, instructors and the students.

It can also be argued that there is a higher possibility of missing relevant aspects of a situation if only one method – either qualitative or quantitative is used (Venkatesh, Brown, & Bala, 2013), and using both qualitative and quantitative methods may lead to

more comprehensive information collection than using just one approach (Creswell & Plano Clark, 2007). Further advantages of using a mixed methods approach include reduction of biases as additional methods are expected to overcome the limitations of each other. Corroboration and convergence of findings from the different methods of data collection; and revealing more insights and depth during analysis that may not be possible with using only one method (Migiro & Magangi, 2011) It can also be argued that mixed methods add to the credibility of the study (Hussein, 2009) and attain more reliable, accurate, and contextually rich findings (Frechtling & Sharp, 1997).

The use of mixed methods is therefore grounded in the researcher's belief that findings from each set of participants (students, instructors, and dean of engineering) will give not only a richer depiction but also a unique description of what LBD practices and 21st Century Skills are currently implemented at the selected institute.

3.5. Mixed Methods Design

Several researchers including Bryman (2006), Creswell and Plano Clark (2007), Greene (2007), Morse (2003) and Teddlie and Tashakkori (2009) have discussed mixed method design. This section presents the research typology, research design, and integration used in the current study and situates them within the context of literature.

3.5.1. Research typology.

Teddlie and Tashakkori (2011) developed a typology of mixed method approach, using a three-stage process for arriving at the research design. The first stage is related to the conceptualization of the research problem and the development of the research question. Next is the experiential stage, where decisions are made related to the methodology for data collection and analysis. The final stage is the inferential stage, where the focus is on theory development and explanation. The current study follows a similar typology, moving from the conceptualization of the problem to the experiential stage where data collection and analysis methodology is established and finally to inferential stage that is expected to lead to the development of a new LBD pedagogical model.

3.5.2. Research design.

According to Teddlie and Tashakkori (2011) mixed methods typology presents the possibility of four research designs: parallel mixed, sequential mixed, conversion mixed.

1. **Parallel Mixed**

This design enables the research to be conducted using two or more methods of data collection in parallel. The findings are synthesized from each strand and inferences made at the end of the study.

2. **Sequential Mixed**

This allows for chronical ordering of the data collection, with either quantitative or qualitative data being collected first and then followed by the other method. This method can also be used to draw inferences after synthesizing findings from each strand separately, or by merging the data collected from the two methods.

3. **Conversion Mixed**

A conversion design allows for the mixing of quantitative and qualitative data at all stages of the study. In this case, first, either quantitative or qualitative data is analyzed, and then transformed and analyzed using the other method.

4. **Fully Integrated Mixed**

This approach allows for the mixing of data from different methods in a more interactive and integrated manner throughout the study (Teddlie & Tashakkori, 2006).

The current research question and sub-questions call for a selection of the parallel mixed method design as the best suited to providing answers and attaining the objectives. The researcher needed to select the most appropriate research design for the study, taking into account the qualitative and quantitative approaches as they relate to each other.

Before deciding upon the research methods for data collection and analysis, it is essential to determine how the data collected from diverse methods would interact with

each other or inform the overall research. Creswell (2003) listed four key criteria for choosing a mixed methods design. They are as follows:

- The first criterion determines the level of interactions (independent or interactive) between qualitative and quantitative methods, and this decision is considered as the most critical for mixed methods based research study (Greene, 2007). In the current study, the data collected from the qualitative and quantitative methods are merged interactively, but after being independently collected and analyzed in a parallel design approach.

- Next, it is important to establish the priority for each method or whether to treat both methods with equal priority. This study treats both strands of data collection method with equal priority, which is typical of parallel mixed method design approaches (Creswell, 2003).

- The third criterion addresses the timing or sequence of data collection methods in the current study; the qualitative data were collected first, followed by quantitative data, which is also aligned with the parallel mixed method research designs (Creswell, 2003).

- Finally, it is important to evaluate the theoretical perspectives used in the research and to establish its scope and utility to inform the analysis. The current study has used theoretical perspectives that inform the merging and synthesizing of the data collected from the two independent data streams, which again is a characteristic of the parallel mixed method research design (Creswell, 2003).

3.5.3. Data integration.

To complement the parallel mixed design strategy, the approach to mixing or merging the diverse data sets needed to be evolved. Morse and Niehaus (2009) discuss mixing strategies and data integration in mixed method research and advise that when using a data merging or mixing approach, it is necessary to select a point of integration, or the point at which the data merging is to be conducted. This decision depends on the

type of data that have been used, and the design approach that is guiding the data collection process.

Data integration is undertaken by joining data obtained through different methods to answer the research questions. Data integration has salient importance in mixed method research designs, and it can be undertaken through separate and independent synthesizing of data streams and merging at the end; or through merging at intermediary stages. Data integration also requires determining the point of integration (Fielding, 2012). It is possible to establish this point of integration at different points – at the design stage, during the collection stage, during the analysis stage, or during the interpretation stage (Creswell & Plano Clark, 2011). The current study established the data integration point as post-analysis of independent data streams. It was after the findings of the two independent methods were collated and analyzed, that they were merged cohesively by reading together and adding to each other.

According to Fielding (2012) some of the benefits of data integration include better illustration, convergent validation, and analytic density.

1. **Illustration** – Mixing of data enables a better presentation of the research findings, as quantitative data presented in the form of graphs and charts can be complemented with a qualitative discussion that can lend deeper understanding and insights (Creswell & Plano Clark, 2011).

2. **Convergent Validation** – Data integration adds to convergent validation of the research and establishing the robustness of the research design by showing that the findings obtained from different methods align. Also, more than one method of data collection reduces errors and eliminates any limitations associated with using only one method (Creswell & Plano Clark, 2011).

3. **Analytic Density:** Data integration adds to analytic density, or the ability to validate findings and verify the data collected from diverse sources.

As the research design selected was the parallel mixed methods design, and, both qualitative and quantitative data were collected simultaneously then analyzed independently and later merged, the research was able to ensure convergent validation by comparison of the findings from the two data strands in terms of their compatibility. Also, the presentation of the merged data provides both visual illustration (in the form of graphs and figures) and descriptive qualitative discussion. The analytical density of was also enhanced as merging the two data streams led to the evolution of rich contextual and holistic themes – that could capture the essence of the entire research findings in a more lucid and comprehensive form.

3.6. Parallel Design Strategy

The present study had three sets of participants (instructors, engineering dean, and engineering students). The students responded to closed-ended questions using a survey, while the instructors and the engineering dean responded to semi-structured interviews using open-ended questions. Their responses guided the flow of the questions which were instrumental in obtaining insights regarding their current understanding and practices of LBD and 21st Century skill at the target institute.

The research sub-question #1, "What are the current understandings of LBD from the viewpoint of the engineering dean and the instructors?" was answered using a qualitative data collection method, where data were gathered through in-depth semi-structured interviews. For a complete list of interview questions, please refer to Appendix A. Sample list of the questions is listed below:

- How would you define Learning-By-Doing?
- What LBD activities do you do or have done to teach the students?
- Which one do you think worked best? Why do you say it works?
- How do you plan LBD activities?

Participant responses to the semi-structured interviews questions provided insights into the perspectives of the instructors and engineering dean regarding the implementation of LBD as a teaching methodology and the use of 21st Century Skills in course delivery and assessment. The responses obtained from the interviews were coded and categorized. They were then documented and analyzed in detail to get clearer and deeper understandings of both LBD and 21st Century Skills in the context of the Institute.

The responses obtained from the students using an anonymous online surveys, and instructors' interviews addressed research sub-questions #2 and #3, "From the perspectives of instructors and students, what LBD practices are successfully implemented in the engineering department?" and "From the perspectives of instructors and students, what 21st Century Skills are taught and assessed in the practice of LBD?"

The LBD survey was administered to 218 engineering students, with 184 responding to the survey. Specifically, the students were presented with the statements of 16 LBD practices and were asked to provide their responses on a 5-point Likert scale ranging from a response indicating activity in each particular statement was performed from *Never, Almost Never, Occasionally, Usually and, Always*. Table 3.2 describes the meaning associated with the descriptors of the Likert scale from 1 to 5.

Table 3.2

Explanation of Likert-Scale Used in LBD Survey

Scale	Description
5	Always
4	Usually
3	Occasionally
2	Almost Never
1	Never

To encourage students to give honest and unbiased responses, their identity was kept anonymous. The surveys were distributed after obtaining approval from the concerned students, instructors, and the authorities (see Appendices B, C, and D). The surveys were comprised of objective questions, and the responses analyzed using descriptive statistics. For a complete list of LBD and 21st Century Skills survey questions, please refer to Appendix E and F.

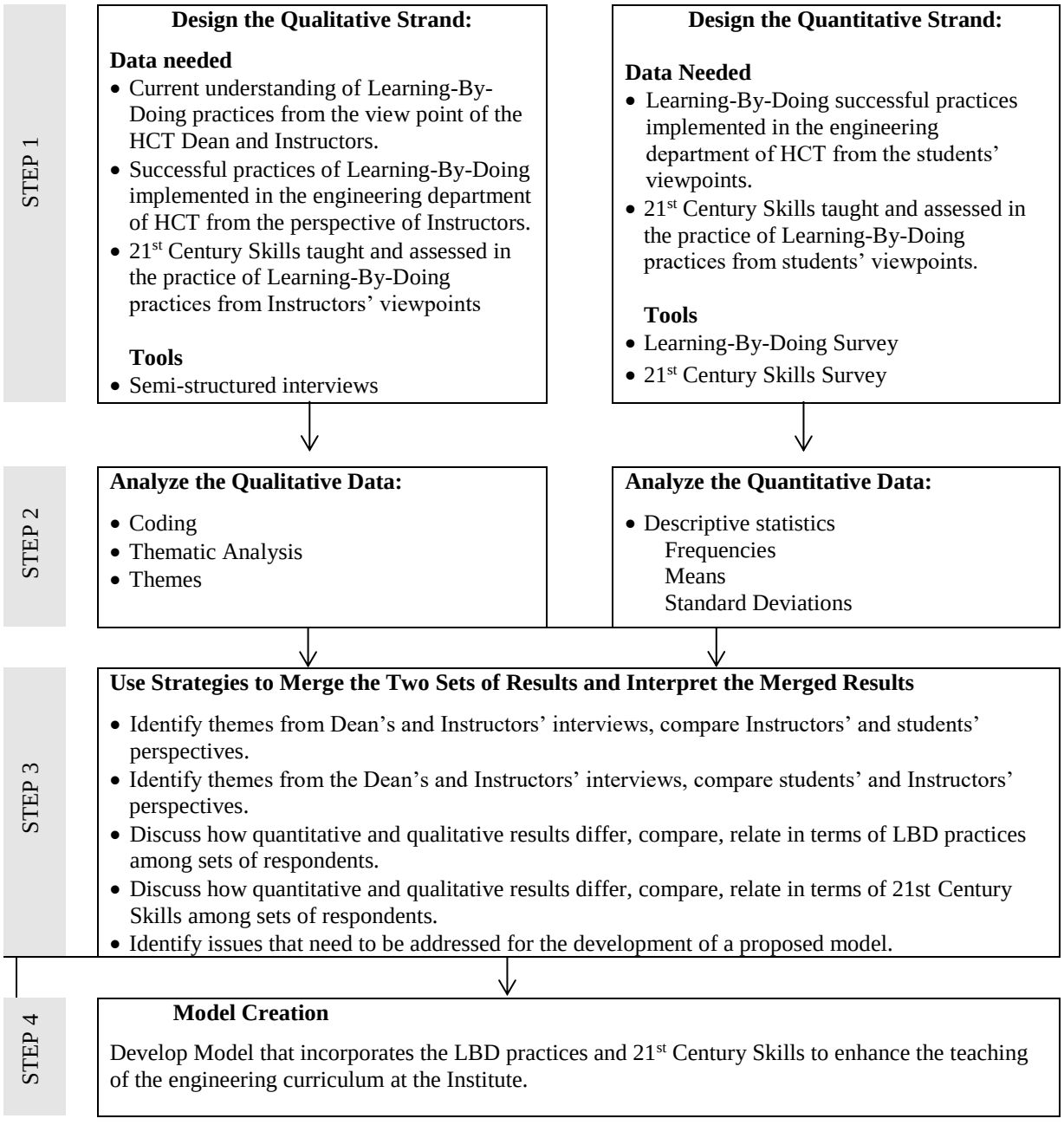
Sample list of the LBD survey statements is listed below:

- Discussions in the classroom are interactive, meaning students as well as the instructor, contribute to the topic being discussed.
- Questions and answers that focus on the post-evaluation of learning activities are conducted in the sessions.
- Exam questions are focused on scenarios that require students to apply what they have learned and are not merely limited to ones that call for memorization, definitions, etc.
- The instructor uses real-life case studies as a means for teaching the content of the course.
- The instructor recognizes my original ideas in the classroom by giving me extra points or positive feedback.
- Instructors encourage oral communication through activities that require presentation of ideas to others.
- Instructors conduct classroom activities that encourage interaction among students.
- Instructors include collaboration as one of the rubric guidelines for marking a classroom activity.

The quantitative and qualitative data were collected and analyzed independently; the results of both were then integrated and interpreted together and are presented in Chapter #6 which merges the results obtained from the surveys and interviews to answer

all research questions and discusses the insights developed from the combined findings, leading to the development of the proposed new LBD model.

Figure 3.1 shows the complete research methodology and underscores how it satisfies the aims and objectives of the study.



Adapted from Creswell and Plano Clark, 2011, p. 79

Figure 3.1. Convergent Parallel Design

In summary, this research adopted a parallel mixed method research design and collected data concurrently, allowing the implementation of both the quantitative and qualitative strands during a single phase of the study. The two methods were used to obtain data from two different sets of participants (qualitative – instructors, dean and quantitative- students), and the findings from each strand were analyzed independently of the other, with integrating of data being employed only at interpretation stage.

3.7. Quantitative Tools

The current study employed quantitative tools to obtain data from the students. Quantitative research is predominantly aimed at discovering new information but by reducing or eliminating the context of the settings (O'Dwyer & Bernauer, 2014). The quantitative methods are often used in social science as they simplify a complex situation enough to be analyzed using quantitative data analysis and interpretation (Morgan & Smircich, 1980). By using numerical indicators to ascertain relative aspects of a situation, quantitative methods can give a clear indication of the dynamics apparent in that situation (Frey & Kreps, 2000). As it was appropriate to survey sufficient students to get a representative sample of the student population, a quantitative approach was found useful as it enables faster data collection.

The students were requested to respond to the Likert scale questions by completing an online survey. Following the recommendation made by Lavrakas (2008), to avoid participant fatigue, the surveys were kept short and divided into two sets: LBD elements and 21st Century Skills and conducted a week apart. To avoid a language barrier for some students, both surveys were written in English and formally translated to Arabic by the target institute translation department. This was done as the students were more versed in Arabic than English, and questions in English, may not be understood fully or as intended by the researcher (Emery, 1987). This translation into Arabic ensured that the students were able to grasp the full meaning of the questions asked and give answers without being confused by any language related nuances.

However, before the actual survey was conducted, a pilot survey was undertaken to attest the validity of the research survey.

3.7.1. Pilot survey.

A pilot survey was conducted before the actual research was undertaken. A sample of ten students randomly selected was used to test the online survey, and to detect any barriers to successful completion. A pilot survey is used to improve the study instruments and detect any errors in advance before introducing them to the participants (van Teijlingen, Rennie, Hundley, & Graham, 2001). The pilot survey was, therefore, conducted to keep track of the time needed to complete the survey and to find out if students encountered any problems in answering them. Additionally, the pilot survey sought to reveal whether the survey was of appropriate length and difficulty, thus enabling further editing before the actual survey was launched. Also, the purpose of the pilot survey was to check the clarity of the survey items and to rule out ambiguities or complexities in the technical jargon involved in the study (Cohen, Manion, & Morrison, 2002). After this trial assessment, a change to the surveys included: question five was changed from "real life problems" to "real life case studies"; and question fourteen was clarified by adding "Examples of these types of activities are role-playing, re-enactment or walkthrough (from process to output)". These adjustments were necessary because the respondents needed further clarifications to understand those questions.

3.7.2. Survey.

The survey was developed based on the belief that a quantitative data collection instrument was the most effective way to collect data from the student population on their perceptions of which LBD and 21st Century Skills occur in the classrooms. A survey can yield data that is analyzed numerically to evolving trends in opinions or attitudes of a sample, and hence enables making generalizations about the population under study (Creswell, 2009). Fink (2000, cited in Creswell, 2009) states that quantitative surveys can be administered in four different ways in the form of interviews, structured record reviews, observations, or self-administered surveys. The

current study used self-administered surveys, as these are found to be less time consuming and provide greater privacy and ease to the respondent (Creswell, 2009).

The researcher was aware that any self-report survey has several well-documented limitations in the form of respondents' bias, respondents' discretion, or falsification of data (Spector, 1994). However, the survey method provides several benefits, in the form of data collection from a large sample within a limited period (Kirakowski, 1997) and ensure confidentiality (Gilbert, 1993) and objectivity (Moser & Kalton, 1979). Also, a self-report method is justified in the case of the current study, as the students may be in a valid position to report what they consider as they are learning (Carroll, 2002). As such, the survey was administered online, through invitation, and the participants were provided the survey link.

The quantitative data obtained were compiled and analyzed using statistical tools like frequencies, means, and standard deviations.

3.8. Qualitative Tools

The qualitative data collection method yields in-depth and contextual perspectives of the research participant and hence leads to greater insights for the researcher (O'Dwyer & Bernauer, 2014). This is possible as qualitative methodologies aim to find new knowledge but within the contextual complexities of the settings according to O' Dwyer and Bernauer (2014). A large number of qualitative data collection tools exist, including direct observation, interviews, focus groups, and the Delphi technique (Denzin & Lincoln, 2005). The selection of the specific data collection tool depends on the researchers' skills, the choice of the data collection strategy, the nature of the research variables, the data collection location and the level of accuracy that is acceptable (Creswell & Plano Clark, 2011). The current study selected a direct personal interview method and was expected to yield in-depth contextual information from the target respondents – the dean and the instructors – who were directly involved in the situation under study.

3.8.1. Interviews.

Denzin and Lincoln (2005) assert that a direct personal interview method is effective because of its ability to capture sophisticated responses and to elicit in-depth and detailed data from the participants. Semi-structured interviews also enable the researcher to ask additional questions, to seek further clarification, and to explore additional or follow-up on information (O'Dwyer & Bernauer, 2014). Since the qualitative approach aimed to collect information regarding the experiences and perspectives of the instructors and the dean, an open-ended semi-structured set of questions was used to facilitate detailed responses. Open-ended questions are non-restrictive and allow the researcher to interview in a manner that ensures a substantial collection of contextual information and in-depth discussion on the subject at hand (Leedy & Ormrod, 2001).

Approximately one hour was allocated for each interview, and the respondents were apprised in advance of the purpose of the study and how their responses would be used in the research report. It was explained that the focus of the study was on successful practice, which was in line with the goals of the college and would eventually benefit instructors and students. The interviewees were also asked to sign an informed consent form confirming their voluntary participation. They were assured that they could leave the research at any time they wished. The responses were recorded with permission from the respondents, and the audios were subsequently transcribed using the Microsoft Word application. All interviewees were referred to as Instructor # to ensure their participation remained confidential and anonymous.

3.9. Participants

The target population of this study includes the teaching staff of the engineering college, the dean of engineering, and students of the engineering department. All engineering students were invited to participate in the quantitative data collection part of the research (N=218, where N represent the total population). One hundred eighty-four chose to complete the survey (n=184, n represents the subset). All eight members of the

teaching team and the dean of the engineering program were asked to participate in the qualitative data collection part of the research. All nine consented and participated. Table 3.3 outlines the participants that completed data collection for the study. The female college started two years after the male college, therefore there were no female students in the engineering program in year 3 and year 4 at the time of conducting the survey for the current study.

Table 3.3

Participants of the Study

Colleges	***students***				***Instructors***	***Dean***
	Year 1	**Year 2**	**Year 3**	**Year 4**		
College 1 (female)	49	31	0	0	5	
College 2 (male)	30	41	32	18	3	
Total	**79**	**72**	**32**	**18**	8	1

Student participants were advised of the informed consent form and were invited to read and sign it. This form was attached to the survey link. Participation was completely voluntary, and students could withdraw from the study at any time. It was explained that the focus of the study was on successful practice, which was in line with the goals of the college and would eventually benefit instructors and students. Furthermore, the student participants were advised of the utility of their responses and to whom their responses will be reported.

3.10. The Researcher

The researcher's interest to conduct the research is a result of his educational experiences in the engineering field. The researcher was the academic manager at the time of conducting the research in the engineering department; hence, he was acutely vigilant with his dual role of researcher and manager in interpreting qualitative results as these might have been shaped by his personal experiences as a member of the institute.

Necessary steps were taken to ensure that all participants in the research understood the process in which they were engaged.

Their consent to participate in the survey was one of the requirements of the ethics approval process. The participants were provided information about how these responses would be used in the study. In particular, the student participants were informed regarding the utility of their responses and to whom their responses would be reported. It was clear that the research focus was about successful practice, which is in line with the goals of the institute and would eventually benefit instructors and students. It was made clear that participation was voluntary and their refusal to participate would not, in any way, be used against their results. To further ensure confidentiality and anonymity of the respondents, the identity of all the respondents was kept anonymous.

In addition, the researcher assured the participants that the results yielded from this study would be used to provide suggestions regarding the LBD strategy and 21st Century Skills.

3.11. Data Analysis and Interpretation

Data analysis is conducted based on the type of data collected (Fraenkel & Wallen, 2000) and as such, a quantitative analysis using percentages and statistical analysis (frequency distribution) on the data collected from the surveys; and qualitative analysis using thematic content analysis on the data gathered from the semi-structured interviews, was carried out.

3.11.1. Methods of analyses of quantitative data.

The quantitative data collected through student surveys were analyzed using Microsoft Excel statistical tools. The data from the LBD survey as well as the 21st Century Skills survey were compiled and analyzed using statistical tools including frequencies, means, and standard deviations. The results were then described with the help of graphs and charts.

3.11.2. Methods of analyses of qualitative data.

The interviews, which were conducted individually and face to face, were recorded and subsequently transcribed verbatim to text. The text was reviewed and coded to provide a framework for organizing the emergent themes.

This process involved multiple readings of the data and coding, which allowed the researcher to take different sections of text from the data and classify them under appropriate themes. These themes were identified by using the actual words that the participants said during the interviews. For clarity and organizing the study, the identified themes were recorded under the particular research question they addressed.

3.12. Reliability and Validity

It is essential to establish reliability and validity of research methods to prevent them from falling into the realm of fiction and simple heresy (Morse, Barrett, Mayan, Olson, & Spiers, 2008). As such, care was taken to ensure the reliability and validity of the research instruments, data collection process, and data analysis process. Validity is established when two methods yield similar results when measuring the same thing, and reliability is established when the same method yields the same result when measuring the same thing again over some time (Campbell & Fiske, 1959) It is generally presumed that mixed methods improve research validity and reliability (Zohrabi, 2013). Though, different criteria being applied to Qualitative and Quantitative research.

3.12.1. Quantitative data: Survey validity and reliability.

The validity of the quantitative research instrument is established if its findings can be used to draw credible inferences about the population (Creswell, 2009) and if the instrument can provide specific and valid answers to the research questions (Somekh & Lewin, 2005). Reliability of the instrument is established if repeated use of the instrument yields similar results, thus ensuring that it is reliable (Somekh & Lewin, 2005).

To ensure the reliability of the survey, the researcher was guided by the LBD and 21st Century elements in the development of the survey questions. Additionally, an

English language expert reviewed the questions and made the necessary adjustments. To further establish validity for the compiled data, the surveys were presented to two independent experts, one expert in LBD from the institute upper administration and the other for 21st Century paradigm from the New York University-UAE. These parties were requested to numerically assess item-objective congruence. They were asked to rate how well the questions met the stated LBD pedagogical philosophy, or 21st Century Skills without revealing to them which specific LBD activities or 21st Century Skills the individual items on the survey were intended to measure, and thus ensuring an unbiased and objective evaluation.

Each expert was asked to evaluate each item within the LBD or the 21st Century Skills survey by giving the item a rating between 1 and -1. A rating of 1 meant that the item was measuring the construct that it was expected to measure and a rating of -1 indicated that the item was not measuring that construct. In addition, 0 was used to denote that the extent to which the item was measuring the context was not clear.

As such, a value of 1 would indicate that the item measured only what it is hypothesized to measure and not any other 21st Century Skill or LBD activity. On the other hand, a value of -1 would indicate that item measured 21st Century Skill or LBD activity that it was not hypothesized to measure, and does not measure those that it was expected to measure. An item is valid if it has a high positive value on the 21st Century Skill or LBD activity that it is expected to measure but low on those 21st Century Skill or LBD activity that it is not expected to measure. As such, the items that were marked as -1 by experts were re-written. Aside from critiquing the survey and making each item valid, this method enabled establishing internal validity of the survey items.

Reliability of the survey instrument was established using the pilot survey with ten students. The survey trial was executed to check the accuracy and to get trial answers, which helped in the modification of questions and helped improve their clarity and in turn, the validity of the data collected from students by ensuring that the instrument had items easily and understood by them. Thus, the survey questions were carefully edited and phrased clearly and unambiguously to make sure they could capture

relevant and valid data. A pilot survey was repeated with the same batch of students, and their scores compared to test the reliability of the research instrument. The findings from the second pilot survey were similar to the first, and hence, this test-retest approach established the research instrument's validity.

3.12.2. Qualitative data: Interview reliability and trustworthiness.

Qualitative research needs to establish validity by ensuring that the findings are based on truth and can be trusted (Guba & Lincoln, 1985). Trustworthiness is an essential element of research validity for qualitative research (Marshall & Rossman, 2011). Several conditions like credibility (that the findings are based on truth); transferability (that the findings can be applied in other contextual settings); dependability (that the findings can be repeated with more research and are consistent); and confirmability (that the findings are based on unbiased, non-subjective approach) (Given & Saumure, 2008).

Reinharz (1992) explains that the reliability of the data collected is enhanced by ensuring that a strong, trustworthy, and honest relationship with the interviewee is in place. The researcher was the Engineering instructors' manager at the time of conducting the research. Hence the researcher made sure to establish his role as a student who is gathering data and not as a manager. Moreover, as such, the researcher ensured that personal views were not reflected in transcribing the qualitative data. Hence, all measures were taken to assure that participants, in the consent form, had the right to refuse to participate and acknowledged that they could withdraw their information from the study at any time without consequences or penalty of any kind. Additionally, to avoid lack of reliability through errors in data collection, the researcher tape-recorded all the interviews, obtained the University of Southern Queensland's Ethics Committee's permission, and also obtained permissions from the interviewees.

Additionally, member checking was done during the interview process to establish trustworthiness. Member checking is done by corroborating the collected data, evolved categories, interpretations, and conclusions with the people from whom the data

was initially collected (Guba & Lincoln, 1985). It is an effective approach to establishing the reliability of qualitative data collection as it highlights the similarities or differences in the researchers' interpretations and member's opinions, thus informing about the reliability of the qualitative process. However, there are also additional benefits as it allows the researcher to explore the perceptions of the participants further and gain additional insights and information and add to preliminary findings (Creswell, 2007).

3.13. Ethical Issues

The utmost care has been taken to ensure that all ethical considerations as mandated for research with human subjects (Resnik, 2011) have been followed. The researcher applied for and obtained ethical clearance, which is a requirement by the policy of the university (Guillemin & Gillam, 2004) before starting the data collection process. More specifically, the researcher maintained respect and protected the confidentiality of the participants in this research. The research participants' names and personal details were kept private and not shared with any third party at any time. All responses were kept confidential, and none of the participants were identified in the research. It was also ensured that no adverse consequences would arise whether or not the contacted target respondents consented to participate, and all those who agreed to participate voluntarily signed a consent form. Data collected from participants were kept confidential, and its integrity maintained through keeping files in password protected folders.

The researcher was the Engineering instructors' chair at the time of the study and was fully conscious of the importance of being ethical at all time and aware that the position of authority could be problematic if the researcher were not reflective and aware of the possible conflict of interest. As such, the researcher engaged in introspection and reflection to ensure that personal opinions did not impact his ability to analyze and interpret results.

3.14. Summary

This chapter presented in-depth the research paradigm, research approach, research methods used for this study. The chapter also discussed the parallel mixed method research design and the qualitative and the quantitative methods used. It developed an understanding of the rationale used for the parallel mixed research design and the choice of the quantitative survey method for students' data collection and qualitative face-to-face semi-structured interviews for the instructors and the dean. The data mixing strategy using the merging of the findings from the two data sets was also discussed in detail. The chapter also discussed the research instruments, validity and reliability, and the ethical considerations used by the researcher. The following chapter will discuss the findings from the quantitative data collection of the research.

CHAPTER 4: QUANTITATIVE DATA PRESENTATION AND ANALYSIS

4.1. Introduction

This chapter includes a presentation and analysis of the quantitative data collected for the study aimed at exploring the institute engineering students' perspectives on the extent to which the LBD and 21st Century Skills have been taught and assessed in their engineering program. The survey results are presented in response to research sub-questions 2 and 3: RQ2, "From the perspective of instructors and students, which LBD practices have successfully been implemented in the engineering department?"; and RQ3, "From the perspective of instructors and students, which 21st Century Skills are taught and assessed in the practice of LBD?" RQ1, which addresses the engineering dean and instructors' viewpoints on Learning-By-Doing and 21st Century Skills. is addressed in Chapter 5.

For questions RQ2 and RQ3, each survey statement is presented with a table of tallied results followed by a description and explanation of the findings. The tables present clear visual results of Raw Data, Means, Standard Deviations, and percentages of LBD statements, which enable a comparison between the differing responses to be readily observed.

The quantitative methodology tools used were the LBD practices survey and the 21st Century Skills completed by one participant group, specifically, engineering students at the institute. The expected outcome of the quantitative analysis was to discover, from the students' perspectives, how LBD is practiced, and whether 21st Century Skills are indeed taught and assessed in their learning experiences. In formulating the questions, steps were taken to ensure that all the questions asked were within the purview and capability of the students. This included presenting the surveys in both English and Arabic to allow the students to grasp the full meaning of the questions asked and to respond without being confused by any language related nuances. Also, to test the validity of the surveys and the process of implementation, a pilot survey was conducted with ten students who were purposefully selected from the

different levels of the engineering program as a trial run before the actual survey was conducted. This helped the researcher to assess the quality of the process and to make any changes necessary before conducting the full primary research investigation. After this trial assessment, some minor changes were made for clarification. As for the means of measurement, the final surveys used a Likert scale to gather responses from all students registered in the electrical and electronics engineering programs at the time of data collection for this study.

The data obtained were compiled and analyzed using statistically calculated frequencies, means, and standard deviations of each item within the survey. Each survey statement is presented in this chapter with a table of tallied results followed by a description and explanation of the findings. The tables present clear visual results, which enable a comparison between the differing responses to be readily observed.

4.2. Findings for Research Sub-Question 2

Research sub-question 2 of this study addressed students' and instructors' experiences of the implementation of an engineering curriculum through the pedagogical approach of Learning-By-Doing. The students' participation was sought through the survey, which sought to understand how LBD is manifested in the engineering program. It was administered to all engineering student participants in this study, including those who had completed the pilot survey. The instructors' participation was through one-on-one semi-structured interviews, and these data are presented in Chapter 5. In the student-presented survey, participants were given a set of LBD principles in the form of specific statements and were asked to rate these statements on frequency of occurrence in class in engineering courses offered in the current academic year at the time of this data collection. The LBD statements, as listed in Table 4.1, were derived from a synthesis of the reviewed literature, in the form of concise and actionable statements which were discussed in detail in Chapter 2.

As discussed at length in Chapter 2, the 16 LBD practices formulated for this survey were based on three foundations: 1) the university's mandate on a Learning-By-Doing pedagogical approach; 2) the present curriculum used by the institute as it

pertains to LBD and 21st Century Skills; and 3) a review of literature that was presented in Chapter 2 of this thesis. Table 4.1 presents the Learning-By-Doing practices that were specified as statements and used in the Learning-By-Doing survey.

Table 4.1

Survey Statements for Learning-By-Doing Practices

	Survey statements for Learning-By-Doing practices
1	There are classroom activities that require students to ***collaborate*** and learn with and from each other. Examples are group projects that emphasize teamwork.
2	Discussions in the classroom are ***interactive;*** meaning students as well as the instructor contributes to the topic being discussed.
3	Questions and answers that focus on a ***post-evaluation*** of learning activities are conducted in the sessions.
4	Exam questions are focused on ***scenarios*** that require students to apply what they have learned and are not merely limited to ones that call for memorization, definitions, and so on.
5	The instructor uses ***real-life*** case studies as a means of teaching the content of the course.
6	Students are presented with ***problem-based*** questions where students are either in a group or individually work out the solutions.
7	The instructor uses ***simulation*** either digitally or manually as a means of teaching a concept.
8	The instructor demonstrates a required ***subject skill*** first then asks the students to follow suit.
9	Students do ***drills and practice*** as a means of learning and mastering a skill or a concept.
10	Students are encouraged to ***reflect*** on what they have learned and express this reflection either orally or in written format.
11	In assessing students' work, the instructor uses other means in addition to his/her assessment. This other means can be ***self-assessment or peer review***.
12	Instructors conduct activities that allow students to fully experience the topic. Examples of these types of activities are ***field trips*** and workshops.
13	The college provides programs that bring students to the ***workplace*** as part of the students' preparation for professional working life after graduation.
14	Classroom activities that ask the students to ***model experiences*** or concepts are conducted. Examples of these types of activities are role-playing, reenactment or walkthrough (from process to output).
15	Instructors encourage students to record ***their impressions*** on how they made the project on a phase-by-phase basis. This requirement is in addition to the required output of the project.
16	Classroom activities are formulated in such a way that students can be more active and motivated in their work. Examples of this type of activity are educational games and other ***hands-on*** means.

The LBD survey was administered to 218 engineering students with 184 responding to the survey. Specifically, the students were presented with the statements of 16 LBD principles and were asked to provide their responses on a 5-point Likert scale - *Never, Almost Never, Occasionally, Usually and, Always* – indicating the degree to which an activity in each particular statement was performed. Table 4.2 describes the meaning associated with the descriptors of the Likert scale from 1 to 5.

Table 4.2

Explanation of Likert-Scale Used in LBD Survey

Scale	Description
5	Always
4	Usually
3	Occasionally
2	Almost Never
1	Never

The mean (*M*) and standard deviation (*SD*) for each set of data were calculated. The mean is the overall fulcrum point of the data, such that, the results higher than the mean suggest an above average response, while results lower than the mean represent a below average response to the statement. The SD represents the degree to which the responses diverge from the mean response. It is indicative of the variation in the responses of the participants.

A Likert scale was used for the survey because this type of response measurement allows for the simple calculation of the mean for each statement's set of responses. The mean is then used to determine the middle ground from which a picture reveals showing the balance of responses. Comparing means from statement to statement also helped the researcher to reflect on patterns emerging from the data. For example, a higher value Mean reflects a higher than average level of agreement with the presented statement. It indicates that the students perceived LBD practices to be implemented more than *occasionally* in their learning.

Table 4.3 presents the collated raw data, means, and standard deviations and percentages of each of the surveyed LBD statements.

Table 4.3

Raw Data, Means, Standard Deviations & Percentages for the LBD Survey

RAW DATA									PERCENTAGE %				
Questions	**Always (5)**	**Usually (4)**	**Occasionally (3)**	**Almost never (2)**	**Never (1)**	**Total Responses**	**Mean**	**Standard Deviation**	**Always (5)**	**Usually (4)**	**Occasionally (3)**	**Almost never (2)**	**Never (1)**
1	48	58	48	22	8	184	3.63	0.58	26.1	31.5	26.1	12.0	4.3
2	45	61	50	19	9	184	3.79	0.67	31.5	31.5	24.5	9.2	3.3
3	45	61	50	19	9	184	3.62	0.58	24.5	33.2	27.2	10.3	4.9
4	39	62	56	19	8	184	3.57	0.56	21.2	33.7	30.4	10.3	4.3
5	36	58	60	21	9	184	3.49	0.53	19.6	31.5	32.6	11.4	4.9
6	22	68	64	22	8	184	3.40	0.59	12.0	37.0	34.8	12.0	4.3
7	41	69	56	12	6	184	3.69	0.64	22.3	37.5	30.4	6.5	3.3
8	55	65	48	12	4	184	3.84	0.69	29.9	35.3	26.1	6.5	2.2
9	52	80	34	13	4	183	3.89	0.77	28.8	43.5	18.5	7.1	2.2
10	38	63	61	16	6	184	3.60	0.58	20.7	34.2	33.2	8.7	3.3
11	28	67	56	21	12	184	3.42	0.56	15.2	36.4	30.4	11.4	6.5
12	30	54	60	25	15	184	3.32	0.47	16.3	29.3	32.6	13.6	8.2
13	28	62	58	21	15	184	3.36	0.52	15.2	33.7	31.5	11.4	8.2
14	32	61	64	17	10	184	3.48	0.55	17.4	33.2	34.8	9.2	5.4
15	54	57	47	20	6	184	3.72	0.62	29.3	31.0	25.5	10.9	3.3
16	42	52	66	17	7	184	3.57	0.55	22.8	28.3	35.9	9.2	3.8

The mean values of each of the 16 statements were measured through a 5-point Likert scale: *Always*-5 to *Never*-1. Using the data in Table 4.3, the mean range was calculated as being between 3.32 to 3.89, with seven of the 16 mean values falling above the mean average of 3.59. There seems to be a general level of agreement amongst the

engineering students toward the more than *occasionally* (average rating of 3) implementation of most of the LBD practices, though perhaps a little less so with statements 12 and 13 which relate to professional life experiences.

Although the mean is a representation of all the data points, it does not capture another important aspect of a dataset which is its dispersion. Dispersion of data points in a dataset is measured by the standard deviation which indicates how much the data points scatter around the mean. The standard deviations (SD) across the statements of this data set range from 0.47 to 0.77. The dispersion around the mean is averaged at 0.62. This can be depicted via the graph in Figure 4.1. Here, the entire data average mean of 3.59 is represented at Zero, while the average dispersion or SD is shown as 0.62.

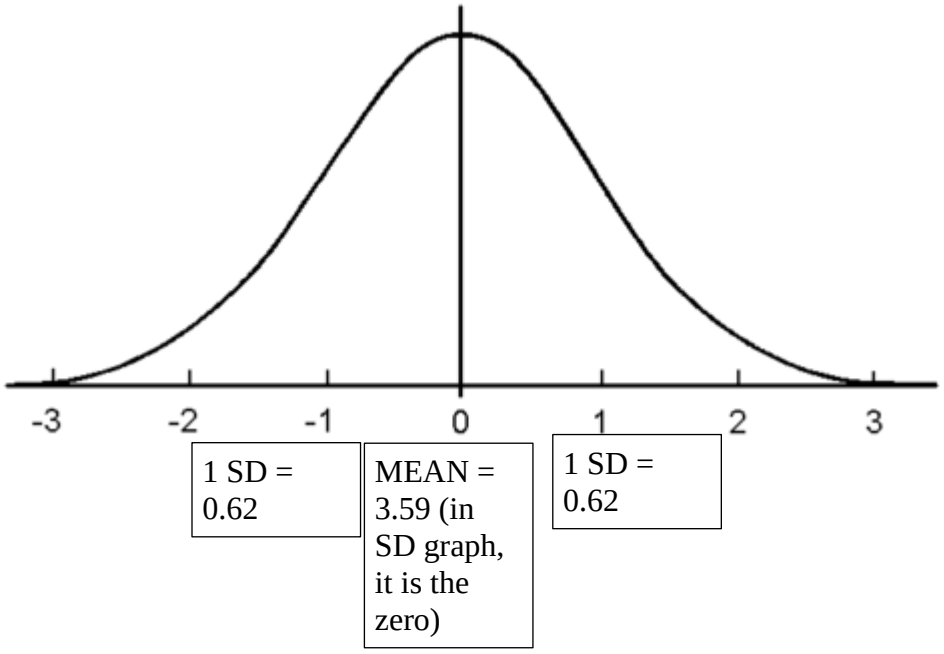


Figure 4.1. Normal Distribution of the 16 LBD statements

4.2.11 Item-level findings of the Learning-By-Doing survey.

While the presentation of the data analysis regarding the frequencies, means, and standard deviations provided a useful overall picture of student perspectives of LBD practice implementation in their programs over the course of the academic year, a closer

inspection of the statement by statement results generated additional insights on how each LBD practice was being implemented from the students' viewpoints.

The findings related to the practice of each LBD practice are discussed as follows: each figure presents a bar chart of the frequency counts of participants' responses and the values of the mean and standard deviation of the responses.

1. There are classroom activities that require students to collaborate and learn with and from each other. Examples are group projects that emphasize teamwork.

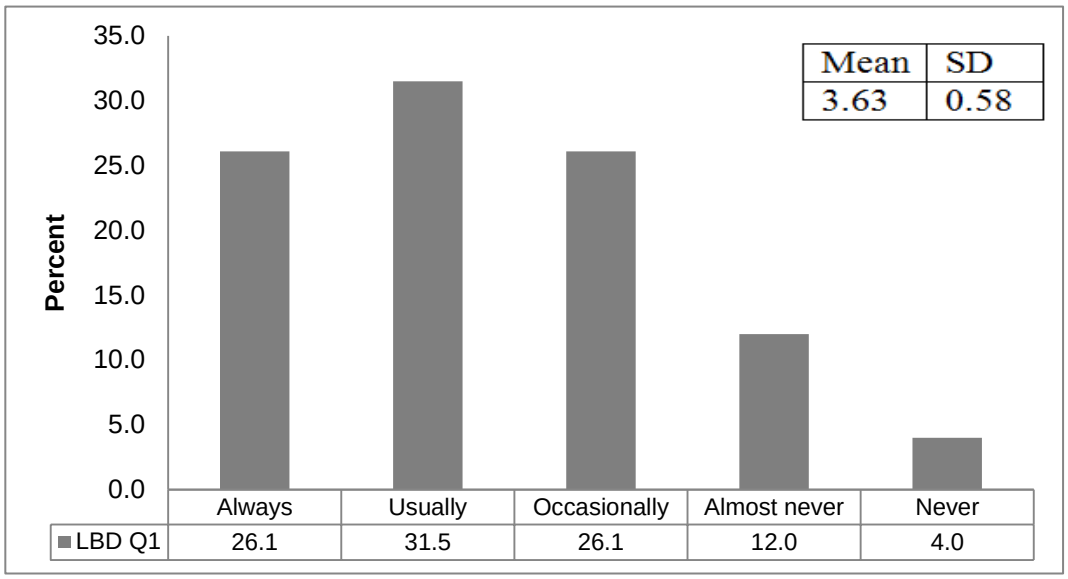


Figure 4.2. Statement 1 LBD practices on collaboration in the classroom

Statement 1 of the LBD survey sought to assess if the students believed that they collaborated in their classroom practice and if this form of activity helped them to learn from each other.

Figure 4.2 shows that 57.6% of the students believed that this collaborative form of learning *Always or Usually* occurs during their program. Overall, this is a positive response, especially when considering that 26.1% of students also indicated that the activity *Occasionally* took place in the class. The mean in this statement's data is 3.63, and the standard deviation is 0.58, which indicates that the responses lie within the Likert-scale range of 3.63±0.58. This indicates that the students' responses did not vary too much – most of them were likely to believe that the activity was undertaken

Occasionally or even *Usually* and that only very few students went to the extreme level on the spectrum and market that the activity either *Never* happened or that the activity *Always* happened. The low standard deviation indicates that the spread of the responses was more concentrated toward the response *Occasionally*.

The mean for this statement is 3.63, which is slightly higher than the average mean for the entire data set (3.59), thus indicative of the fact that this statement received more responses on the higher side (*Occasionally* and above) than the average statement. The SD of 0.58 is somewhere midway between the range of 0.77 and 0.47, or close to the average SD of 0.62, and is indicative of a slightly higher level of dispersion in responses as compared to the responses on the average.

2. Discussions in the classroom are interactive meaning students as well as the instructor contribute to the topic being discussed.

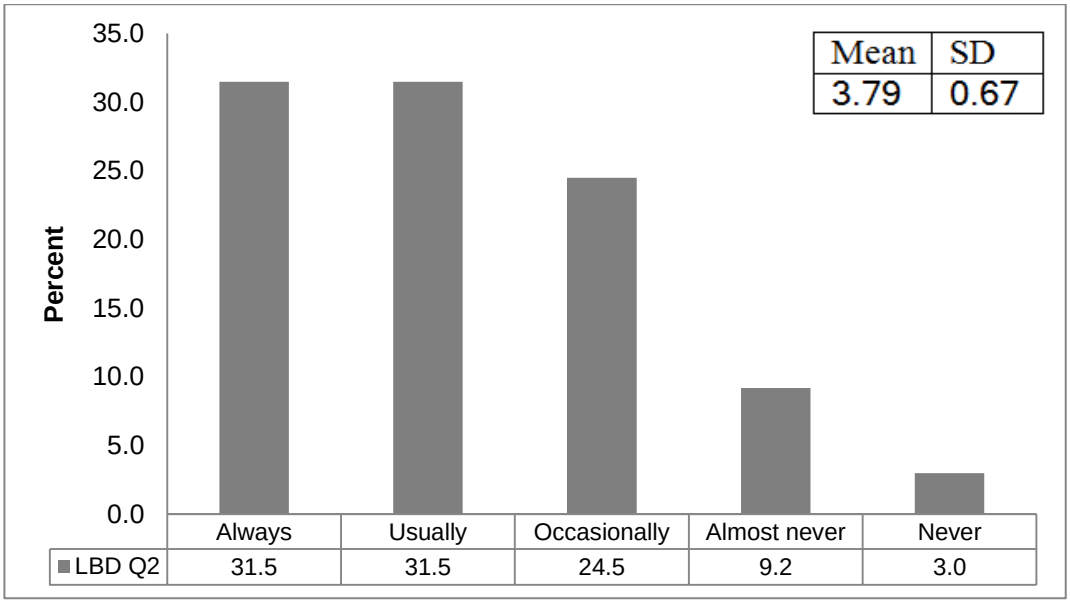


Figure 4.3. Statement 2 LBD practice on using interactions in the class.

The second statement in the survey sought to assess if the participants believed that instructors created an interactive classroom environment. An interactive class is important to any learning experience to facilitate good communication and interaction among students and to support the co-creation of learning.

Figure 4.3 shows that 63% of the students believed that an interactive style of learning took place in the classroom either *Usually or Always*. Also, the analysis revealed in the *Occasionally* category that 24.5 % of the students had marked this category. This means that 87.5% of students believe this LBD practice to be implemented at least *Occasionally*.

The mean for this question is 3.79, while the standard deviation is 0.67. The slightly higher value of the SD (from the previous statement's SD of 0.58) suggests that the participants have a more diverse opinion on the issue of how interactive the classes are, meaning that some were likely to respond very differently (and around the extreme categories of *Never or Always*) from the average response, that is, 3.79 or between *Occasionally* and *Usually*. However, in this case, the mean was higher, and more concentrated around the *Usually* response. This result appears to indicate that a large majority of the respondents did agree that the LBD practice of classroom interaction was evident in class. The responses lie within the Likert-scale range of 3.79±0.67.

The mean for this statement is 3.79, which is higher than the average mean for the entire data set (3.59), thus indicative of the fact that this statement received more responses on the higher side (*Occasionally* and above) than the average statement. The SD of 0.67 is more toward the higher range of 0.77 than the lower range of 0.47 and is indicative of a higher level of dispersion in responses as compared to the responses on the average. This is an interesting finding as both the mean and SD are relatively higher for this statement (Only the means and SDs for statements 8 and 9 are higher). It indicates that this LBD activity drew variety greater range of responses from the students as can be observed from the graph.

3. Questions and answers that focus on post-evaluation of learning activities are conducted in the sessions.

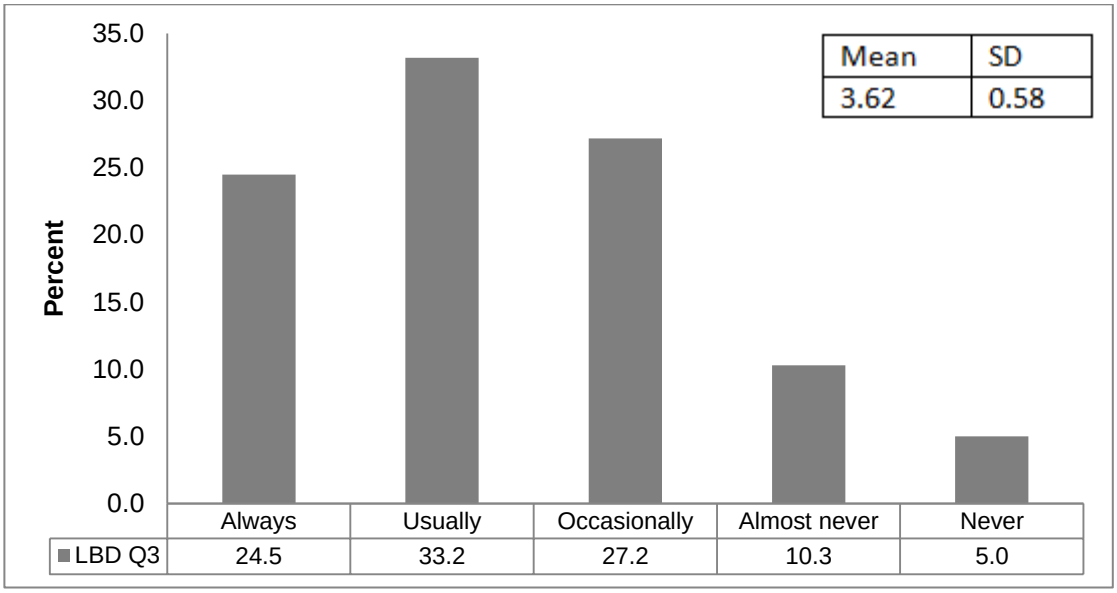


Figure 4.4. Statement 3 LBD practice on using post-evaluation

The third statement in the survey sought to assess the students' perspectives as to whether or not a system of post-evaluation related to any activity in the classroom is being conducted regularly. The concept of the post-evaluation activity in the form of a question and answer (Q&A) of the overall learning experience is to show if the students have understood the lesson and from there if they can apply what is learned.

Figure 4.4 shows that 57.7% of the students believed that post-evaluations were conducted *Always or Usually* in the classroom at the end of the activity. This includes one-third of the students responded that post-evaluation *Usually* takes place during the class, and the other 27.2% indicated the *Occasional* inclusion of post-evaluation practice.

The data reveal that the mean is 3.62 and the standard deviation is 0.58, which indicates that the responses lie within the Likert-scale range of 3.63±0.58. This again indicates that while the students' responses were dispersed less (in comparison to the previous statement), there are some students who responded *Never* and a larger number who responded *Always*, but the majority agreed that the LBD practice of post evaluation was being practiced *Occasionally* to *Usually* centering around the mean.

The mean for this statement is 3.63, which is higher than the average mean for the entire data set (3.59), thus indicative of the fact that this statement received more responses on the higher side (*Occasionally* and above) than the average statement. The SD of 0.58 is more toward the lower range of 0.47 than the higher range of 0.77, but closer to the average of 0.62, and is again indicative of a slightly lower level of dispersion in responses when compared to average statements.

4. Exams use scenarios that require students to apply what they have learned

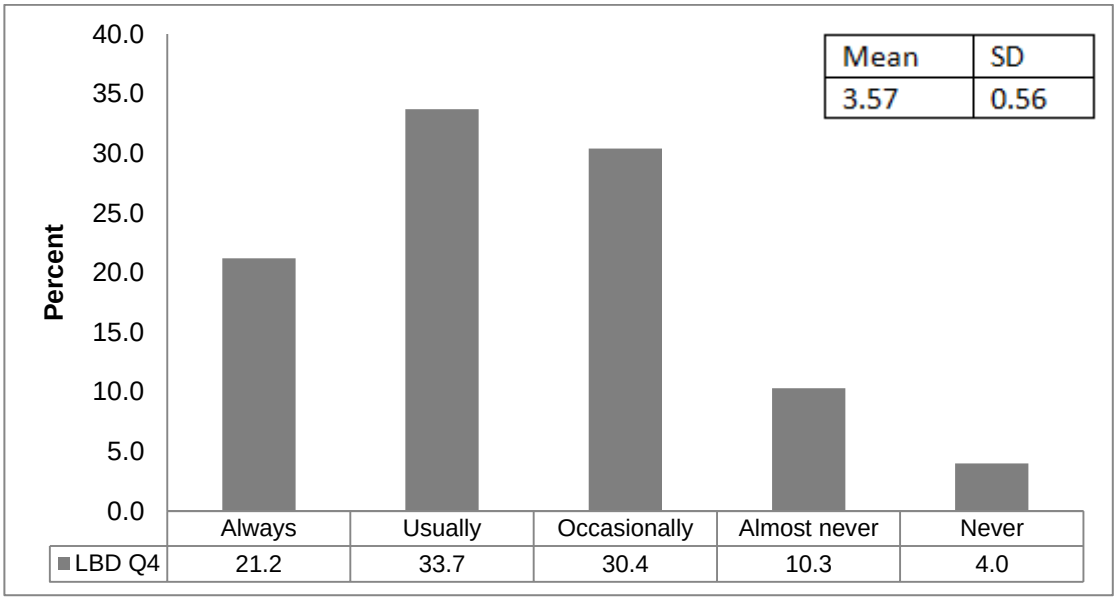


Figure 4.5. Statement 4 LBD practice on using scenario-based problems

The fourth statement in the survey sought to assess if the students believed that in exam situations they were able to apply what they learned in the course of the program as opposed to having just to reiterate what they were told in lessons, which only requires the memorization of content.

Figure 4.5 shows that 54.9% of the respondents reported that they were provided with the opportunity to use the knowledge gained in lessons through practical scenarios. The *Usually* category shows a higher percentage than the *Always* category, but another 30.4% indicated the *Occasionally* response. An analysis of the responses shows that the mean is 3.57 and the result of the standard deviation is 0.56. This indicates that a clear majority of students have responded *Occasionally* or *Usually*, indicating the likelihood that the practice was being implemented in the class.

The mean for this statement being 3.57 (which is lower than the average mean for the entire data set (3.59), implies that this statement received fewer responses on the higher side (*Occasionally* and above) than the average statement. It is also to be noted that this statement (Exams use scenarios that require students to apply what they have learned) is found to have the lowest mean among the statements discussed until now. The SD of 0.56 is more toward the average SD of the entire data (0.62) and is indicative of a slightly lower level of dispersion in responses as compared to the responses on the average of the entire data set.

5. The instructor uses real-life case studies as a means for teaching the content of the course.

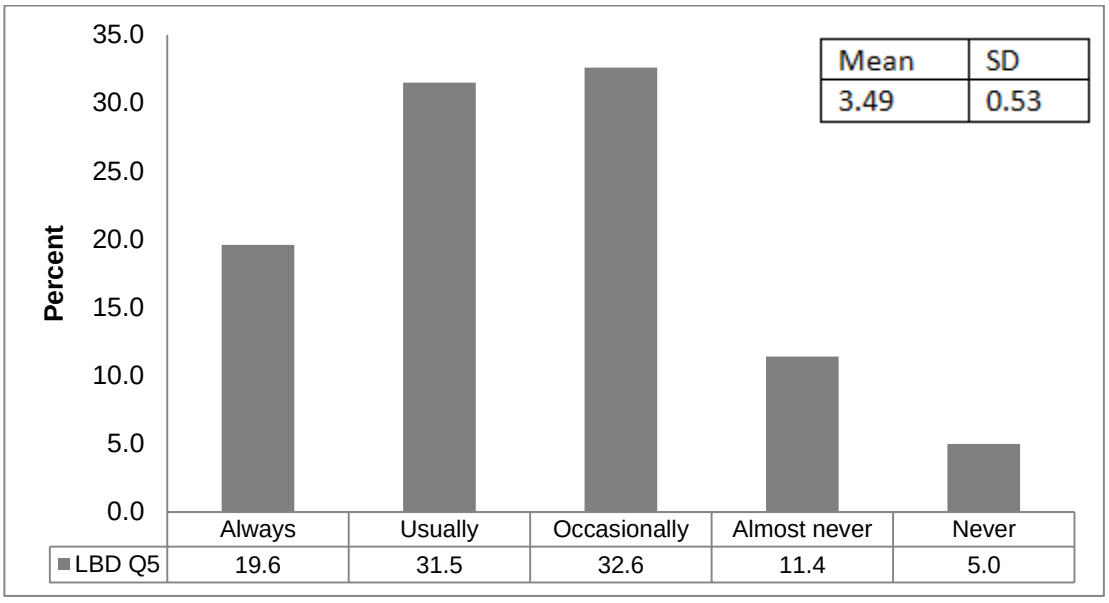


Figure 4.6. Statement 5 LBD practice on using real-life case studies

Statement 5 of the LBD survey sought to assess if the students believed that real-life case studies where used as a part of the content in the course. “Real life case studies” are scenarios that the students will encounter upon working in the “real world”.

Figure 4.6 shows that 51.1% of the students believed that “real life” practical case studies were *Usually or Always* used in the classroom. Overall, this is a positive response, especially when considering that 32.6% of students also indicated that the activity happened *Occasionally* in the class.

The mean for this statement is 3.49, which is lower than the average mean for the entire data set (3.59), thus indicative of the fact that this statement received fewer responses on the higher side (*Occasionally* and above) than the average statement. The standard deviation of 0.53 is more toward the lower range of 0.47 than the higher range of 0.77 and is indicative of a lower level of dispersion in responses as compared to the responses on the average (the average SD being 0.62).

Figure 4.6 shows that 51.1% of the students believed that "real life" practical case studies were *Usually or Always* used in the classroom. Overall, this is a positive response, especially when considering that 32.6% of students also indicated that the activity *Occasionally* happened in the class.

6. Students are presented with problem-based questions where students either in groups or individually, will work out the solutions.

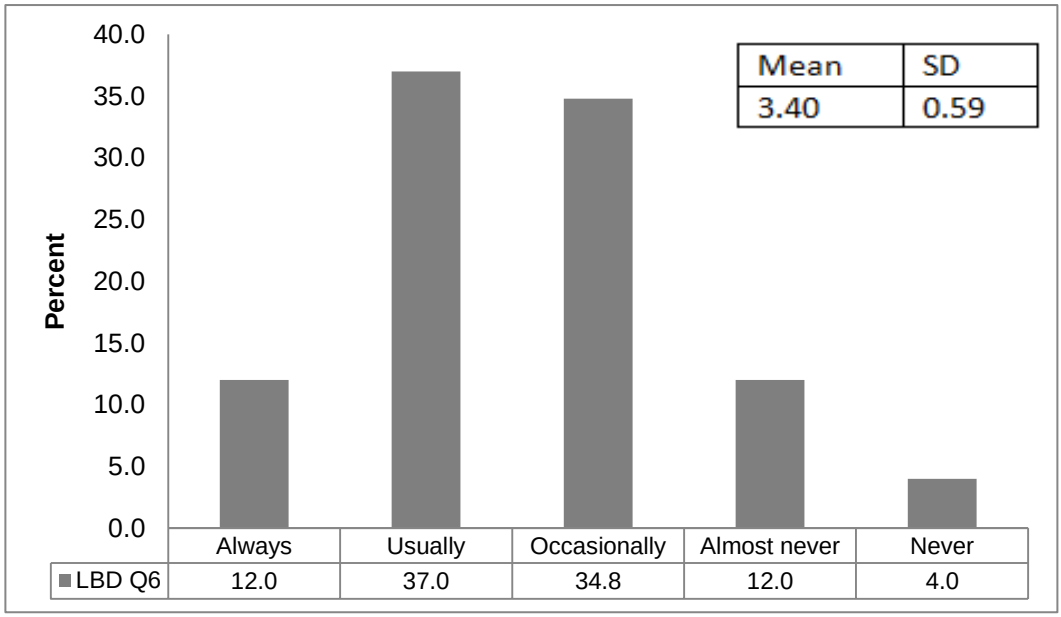


Figure 4.7. Statement 6 LBD practice on using problem-based questions

The sixth statement in the LBD survey sought to assess if the students believed they were presented with problem-based questions in classroom learning practice. This practice included lecture materials with problem-based questions as part of the lesson instruction; problem-based questions as a guide in practical and theoretical practice – for

individual and group practice, and, as part of exam practice, to test whether the students have learned the ability to complete "real life" problems.

Figure 4.7 shows that 49% of the students believed that they were presented with problem-based questions to use in their learning practice within the classroom. 12% of the respondents answered in the *Always* category, and the *Occasionally* category shows 34.8%. This indicates that classroom sessions frequently employed problem-based situations. The use of problem-based questions helps guide students toward applying their knowledge to hypothetical situations and can help them see an issue from diverse perspectives.

The mean for this statement is 3.40, which is lower than the average mean for the entire data (3.59), thus indicative of the fact that this statement received fewer responses on the higher side (*Usually* and above) than the average statement. The SD of 0.59 is more toward the average SD of the data set 0.62 and is indicative of the fact that this statement had an almost similar (slightly lower) level of dispersion in responses as compared to the responses on the average.

7. The instructor uses simulation, either digital or manual as a means of teaching a concept.

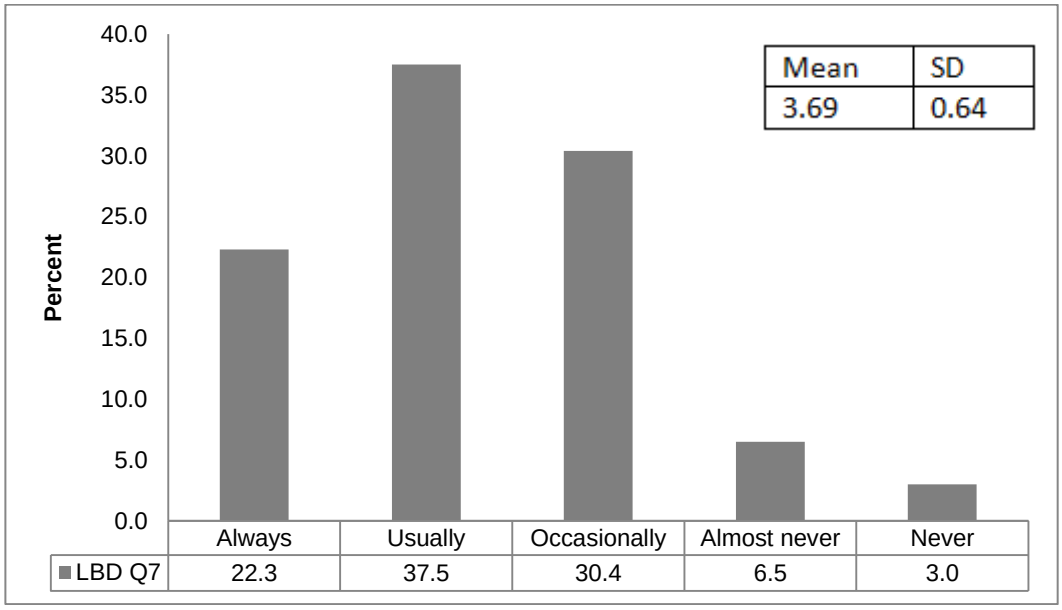


Figure 4.8. Statement 7 LBD practice on using simulation

The seventh survey statement sought to assess if the students believed that the instructor used additional sources, such as digital or manual simulation to demonstrate a concept they were teaching. Using simulation as an effective learning method enables students to gain insights, contend with contextually based problems, reflect and construct new knowledge, and develop new competencies and skills.

Figure 4.8 shows that 59.8% of the students believed that the instructor used additional learning aids. The data show that more than half the class agrees that the instructor is using some form of simulation in the course In both the *Always* and *Usually* category, it is noted that 60% is the highest response thus far in the data presentation, 30.4% of students also indicated that this practice *Occasionally* was practiced with the students in the classroom. In all, 90.4% of the students believed that this practice was being followed (or, this particular LBD activity was undertaken) at least occasionally. This is notable as this is the highest for any statement discussed to this point.

The mean in this statement's data is 3.69, and the standard deviation is 0.64. The *Usually* data responses sit closest to the mean, with *Occasionally* following not far behind. The mean for this statement is 3.69, which is higher than the average mean for the entire data set (3.59), thus indicative of the fact that this statement received more responses on the higher side (*Occasionally* and above) than the average statement.

The SD is a little higher than SD results in other statements, such as the previous two, which appears to indicate that for this question, the participants have more diverse perspectives, or have answered across the different options available on the survey. The SD of 0.64 is slightly higher than the SD of the data set (0.62) and is indicative of a similar level of dispersion in responses as compared to the responses on the average.

Closely observing the graph, we find that the dispersion is across the range of the choices, inclusive of *Always* and *Almost Never*. The values lie within the range from 3.69±0.64.

8. The instructor demonstrates a required subject skill first then asks the students to follow suit.

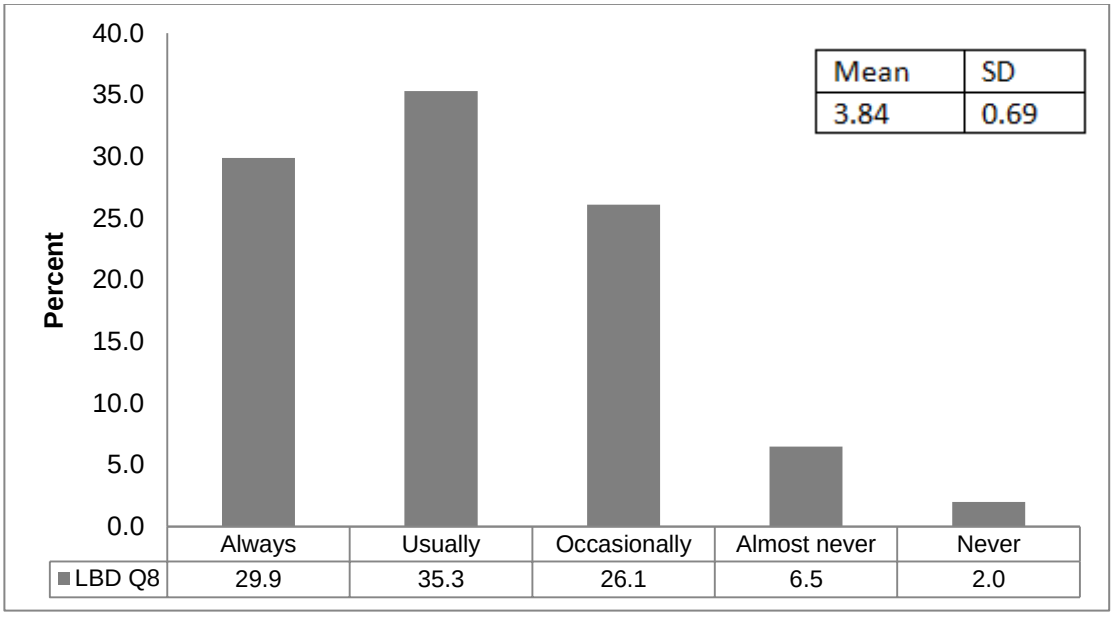


Figure 4.9. Statement 8 LBD practice on Instructor demonstrates essential subject skills

The eighth statement in the survey sought to assess if the students believed that the instructor demonstrated a particular skill first before encouraging the students to try what was demonstrated using the prescribed method.

Figure 4.9 shows that 65.2% of the students believed that the instructor demonstrated the activity before being given a task to do. This is an encouraging response, especially when considering that 26.1% of students also indicated that the activity *Occasionally* took place in the class. The lower two categories of responses, *Almost never* and *Never*, add up to only 8.5%, which is the lowest of all the statements. This overall response appears to indicate that the percentage of times the instructor did fulfill the requirements of the statement were seen favorably by the students.

The mean in this statement's data is 3.84, which is the second highest mean value when compared with the other LBD practices (highest being for statement 9). This is indicative of the fact that this statement received more responses on the higher side (*Occasionally* and above) than the average of all statements. The standard deviation is 0.69, which is the second highest, after that of statement 9. For this statement, the value lies in the range of 3.84±0.69. The SD of 0.69 is more toward the higher range of 0.77

than the lower range of 0.47 and is indicative of a higher level of dispersion in responses as compared to the responses on the average for the entire data set.

It is interesting to note that the fact that while the mean stays around the response *Occasionally*, the students chose to mark across the different categories, on this statement, and hence the graph shows greater dispersion of responses, though the dispersion appears mostly in the positive side of the graph (for responses like *Always*, *Usually* and *Occasionally*) due to the higher mean of the responses.

9. Students do drills and practice as a means of learning and mastering a skill or a concept.

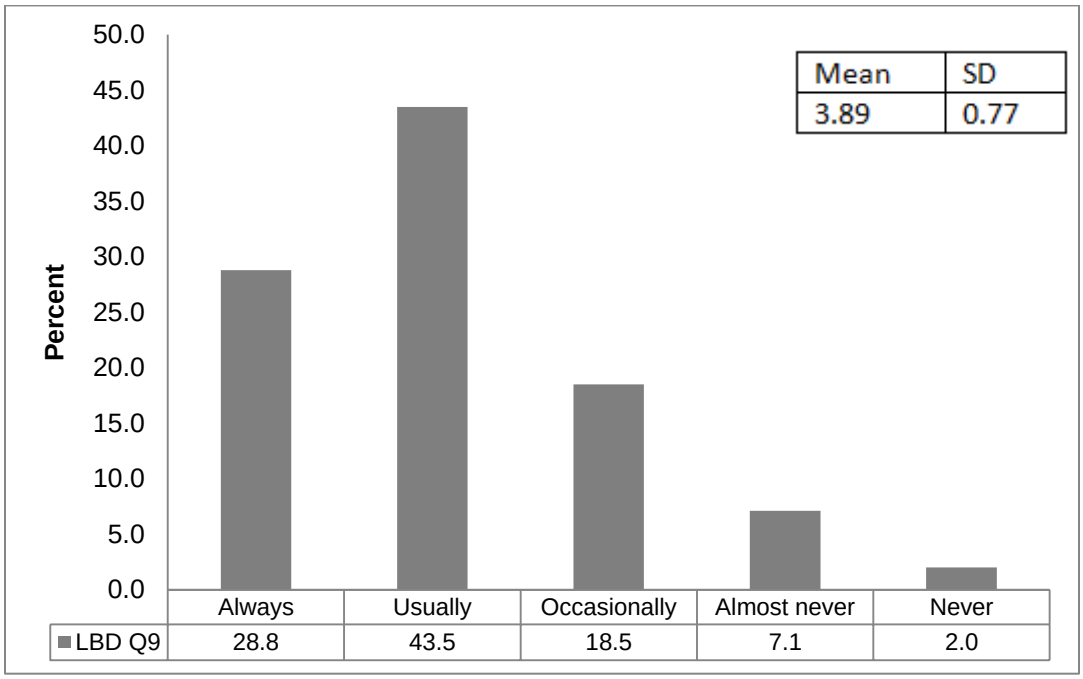


Figure 4.10. Statement 9 LBD practice on students do drills and practice

The ninth statement in the survey sought to assess if the students believed that within the classroom, they were required to participate in drills or practice to learn or master a concept taught by the instructor.

As seen in Figure 4.10, 72.3% of the students' responses indicated that once they learned an activity through instruction, they were given the time and materials to practically apply the theory of that specific activity. This is a higher than average set of positive responses, possibly indicating that the students are making the connection

between theory or learned activity and the practical application of such theory or activity. The overall response is encouraging, especially when considering that 18.5% of students also indicated that the activity took place *Occasionally* in class. The mean in this statement's data is 3.89, which is the highest mean in the data set, and the standard deviation is 0.77, which, too, is the highest in the data set. The responses for this question are largely scattered in the higher ranges of the Likert scale. The value falls in the range 3.89±0.77. The mean is around the category *Usually*, and the responses are scattered mostly between *Always* and *Occasionally*. Here, though the SD is high, the students' responses tended to be clustered between the *Occasionally* and *Always* side of the graph, rather than on the negative categories.

This implies that while there was a dispersion of responses, it was skewed toward the positive affirmations (*Always, Usually, Occasionally*), and hence is indicative of the fact that the students' perceived this activity to be happening, though they may have a difference in opinion about the frequency with which it was taking place.

10. Students are encouraged to reflect on what they have learned and express this reflection either orally or in written format.

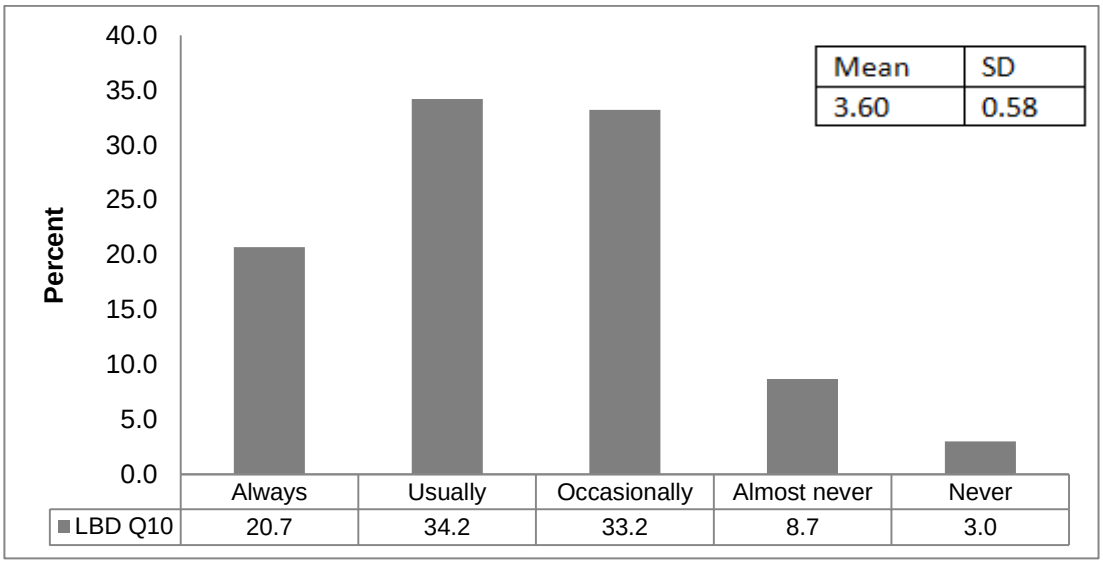


Figure 4.11. Statement 10 LBD practice on using reflection

The tenth statement in the survey sought to assess if the students believed that they were encouraged to reflect on what they learned. The responses to this question

slightly favor a positive response where the students are encouraged to reflect in either oral or written form.

Figure 4.11 reveals that 54.9% of the students believed they used reflection activity in the classroom. Further, 33.2% of students also indicated that the activity took place *Occasionally* during the delivery of the lesson. The mean of this statement is 3.60, and the standard deviation is 0.58 making the values lie between 3.60±0.58. In other words, it implies that most students had marked between categories *Always, Usually, and Occasionally,* since the mean for this statement is 3.60, which centers between *Usually* and *Occasionally* responses. With SD of 0.58, the dispersion of responses is largely between *Always* and *Occasionally,* and very few students have chosen the negative categories of *Almost Never* and *Never.* The results hint at the likelihood that the majority of the students believe they were asked to reflect either in oral or written form to understand the teachings better.

This statement's mean is almost the same as the mean of the entire data set (3.59). The SD of 0.58 is lower than the SD of the data set of 0.62 and indicative of the fact that the responses were less dispersed than the average of the data set.

11. Instructors use multiple methods of assessing students such as self-assessment or peer review

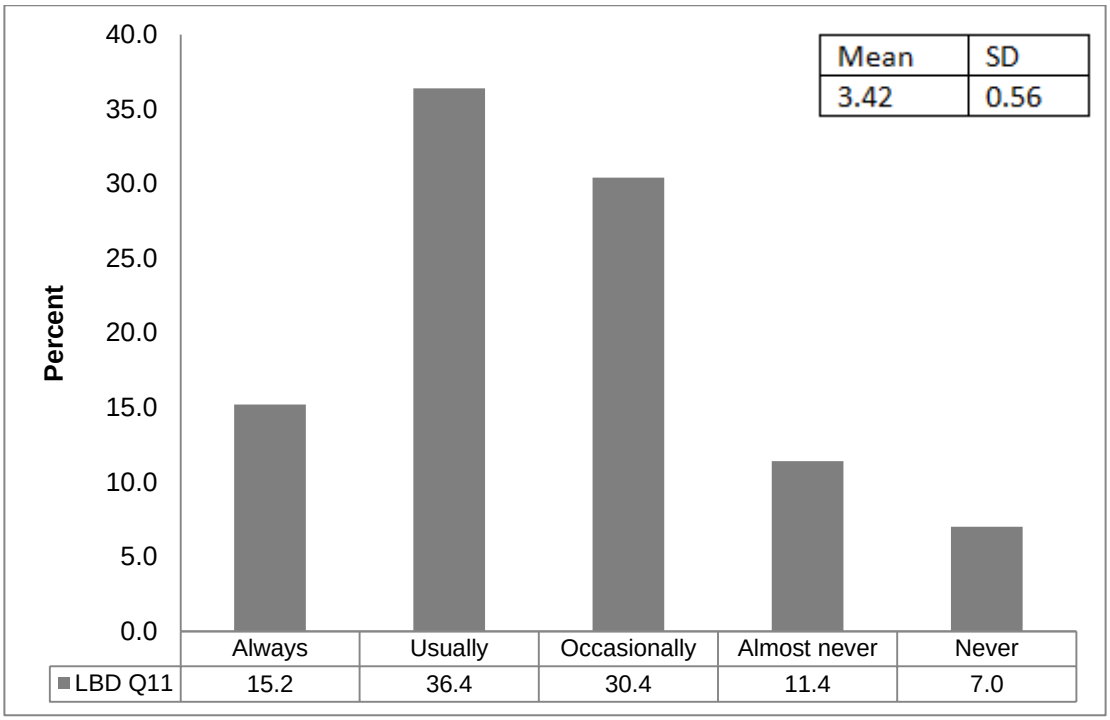


Figure 4.12. Statement 11 LBD practice on using variety of assessment methods.

The eleventh statement in the survey sought to assess if the students believed that various forms of assessment were used within the classroom.

Figure 4.12 shows that 51.3% of the students perceived that the instructor *Always* or *Usually* used different methods of assessment in the classroom. The mean in this statement's data is 3.42, and the standard deviation is 0.56, which indicates that the value lies between 3.42±0.56. These responses show that the majority of the students believed they were being evaluated using multiple methods of evaluation by the instructor. This is because, the mean of 3.42 is centered between categories *Occasionally* and *Usually*, and an SD of 0.56 would indicate that the majority of the responses lie between *Always* and *Occasionally*. The mean, as well as the SD for this statement, is lower than the average of the data set (M=3.59; SD =0.62), which indicates that there is less dispersion of the responses for this statement than in the average data set. It also indicates that there are a higher number of responses for the negative categories (*Almost Never* and *Never*), as compared to the previous statements.

12. Instructors conduct activities that allow students to fully experience the topic

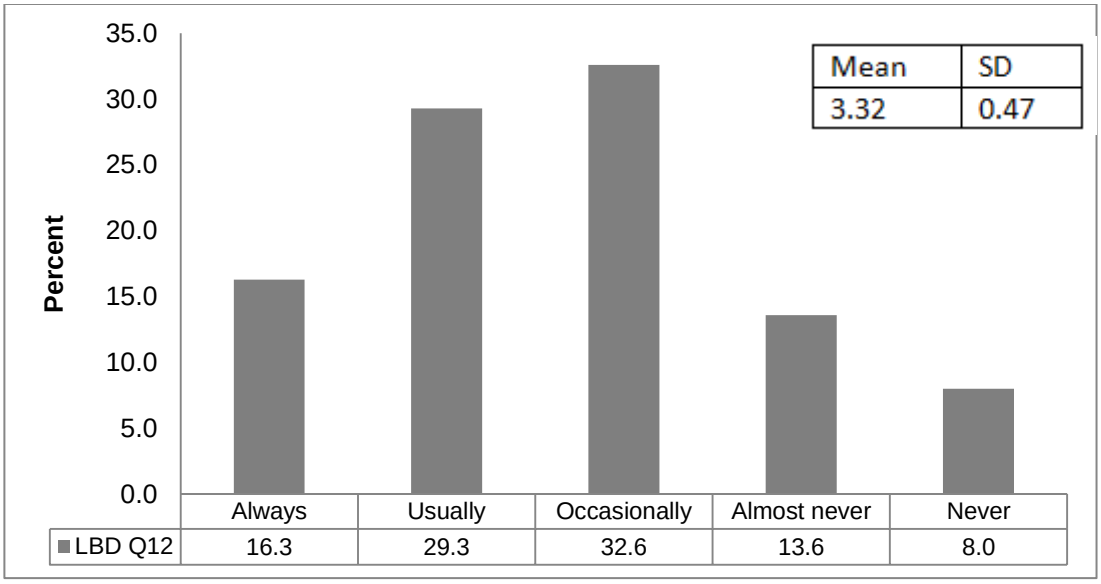


Figure 4.13. Statement 12 LBD practice on using activities to experience a topic

The twelfth statement in the survey sought to assess if the students believed that the instructor found various ways to support topics in the course material.

As seen in Figure 4.13, 45.6% of the students believed that the instructor *Always* or *Usually* used various teaching methods to encourage them to fully experience/understand the content that was being delivered via the lecture. The mean in this statement's data is 3.32, and the standard deviation is 0.47, which implies that the value lies between 3.32±0.47. These findings indicate that the majority of the responses were clustered near the choice *Occasionally.* It is also the lowest mean of the data set. Most of the responses ranged between *Usually* and *Almost Never* (as the mean centered around Occasionally and the SD was low at 0.47). This SD is lower than the 0.62 SD of the data set (in fact, it is the lowest of the data set), and hence indicates a lower level of dispersion of responses across different categories. This statement's response highlights the fact that while the majority of the students perceived their instructors to be expending effort to use different approaches and methods to enable learning, a substantial number of students also perceived that the LBD activity was only rarely being undertaken, if at all.

13. The college program is linked to future professional work life

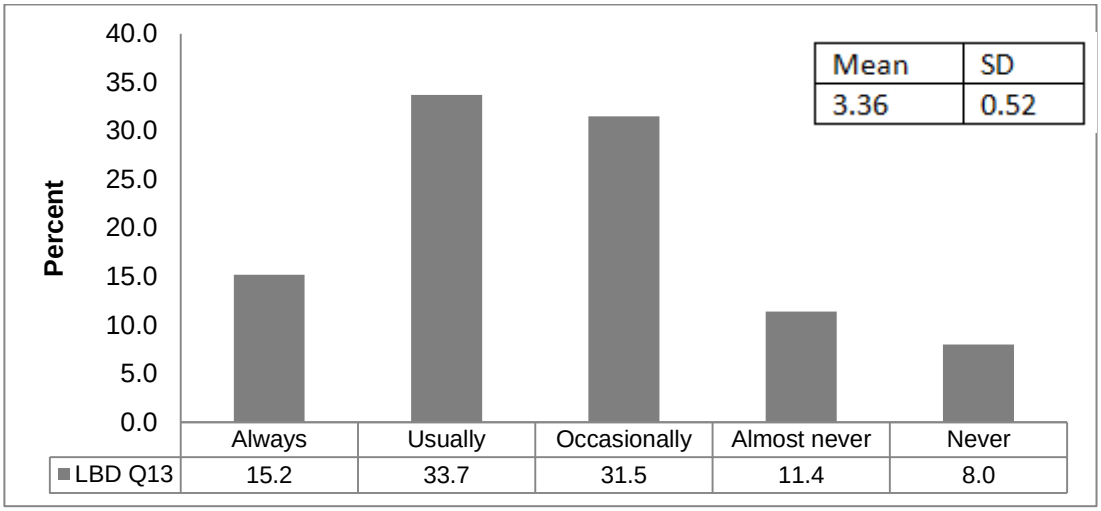


Figure 4.14. Statement 13 LBD practice on linking the college program to future work life

The thirteenth LBD statement in the survey sought to assess if the students believed that the college provides programs that bring students to the workplace as part of the students' preparation for professional working life.

As seen in Figure 4.14, 48.9% of the students believed that such programs existed. This is a below average set of positive responses to the average response of *Usually* and *Always* rankings of other statements in the survey. Results indicate that *Usually* and *Occasionally* responses held almost 66% of the results, which show that two-thirds of the students perceived that such programs existed. The mean in this statement's data is 3.36, and the standard deviation is 0.52. The mean for this statement is lower than that of the data set, which was 3.59, implying that a substantial number of students may have marked categories *Almost Never* and *Never*, as corroborated from the graph of Figure 4.14.

14. Classroom activities that ask the students to model experiences or concepts

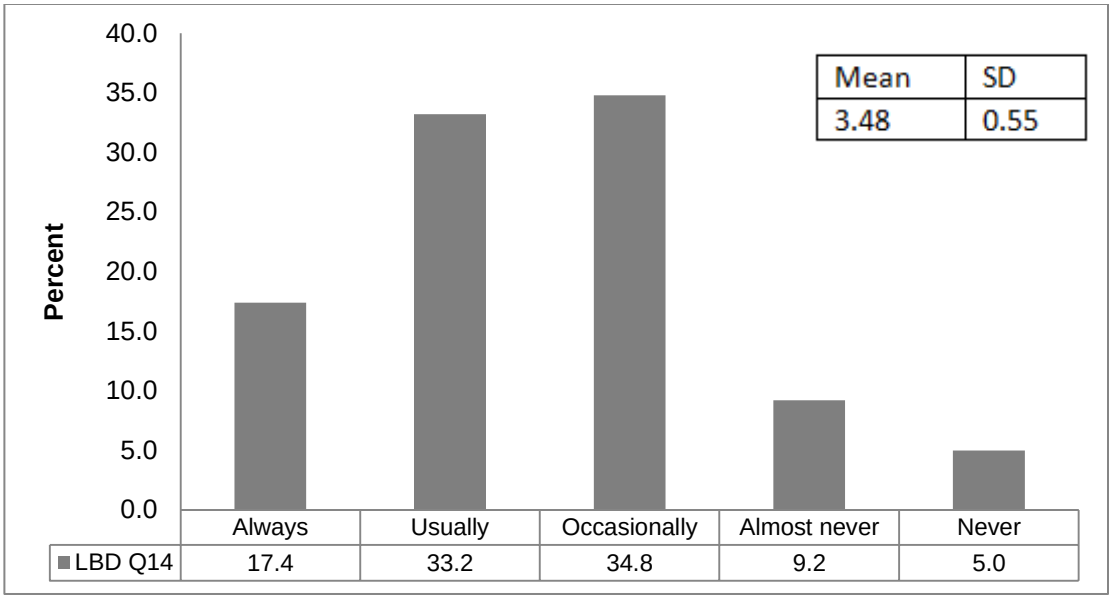


Figure 4.15. Statement 14 LBD practice on using classroom activities to model experiences

The fourteenth statement in the survey sought to assess if the students believed classroom practice modeled real-life experience.

Figure 4.15 shows that 50.6% of the students believed that classroom practice utilized practical experiences and concepts within the lesson. This is a positive response, especially when considering that 34.8% of students also indicated *Occasionally*. The mean in this statement's data is 3.48 and the standard deviation is 0.55. This implies that the majority of the participants indicated that the classroom practice modeled real-life experiences. However, the mean is still less than the mean of the data set (3.59) which would indicate that the number of respondents who mentioned *Almost Never and Never* to be higher than the average of the data set. The smaller SD value, when combined with the low mean, again indicates that there is little dispersion of responses toward the extremities and most students have confined their responses to *Usually* and *Occasionally*.

15. Instructors encourage students to record their impressions

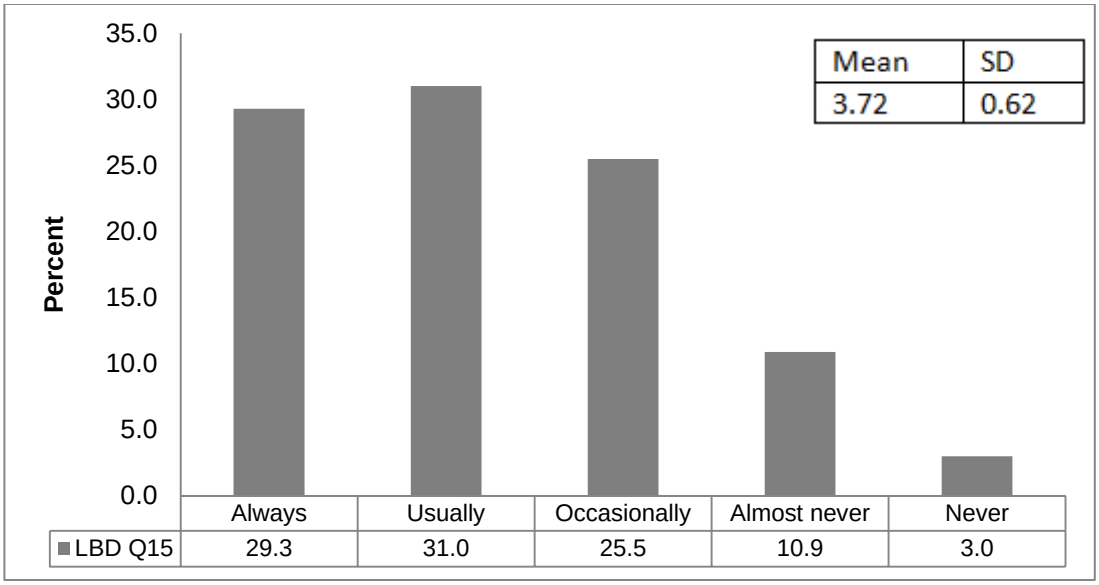


Figure 4.16. Statement 15 LBD practice to encourage students to record their impressions

The fifteenth statement in the survey sought to assess if the students believed that their instructors encouraged them to reflect and record at each stage during their project.

As seen in Figure 4.16, 60.3% of the students believed that their instructor encouraged them to fulfill the self-disclosure portion of "how I did" or "how I applied" as part of the learning experience in their course-required project activity. This is a higher than average set of responses for the *Usually* and *Always* categories. The mean in this statement's data is 3.72, and the standard deviation is 0.62. The mean is higher than the mean of the data set (3.59), indicating that more respondents marked *Always* or *Usually* than in the average data set. The SD is the same as the average SD of the entire dataset. The responses lie between 3.72±0.6. This implies that the dispersion of maximum responses was between *Usually* and *Occasionally*. However, it is also important to note that at least 14% of the students believed that this particular LBD activity was not being enacted.

16. Classroom activities encourage and motivate students

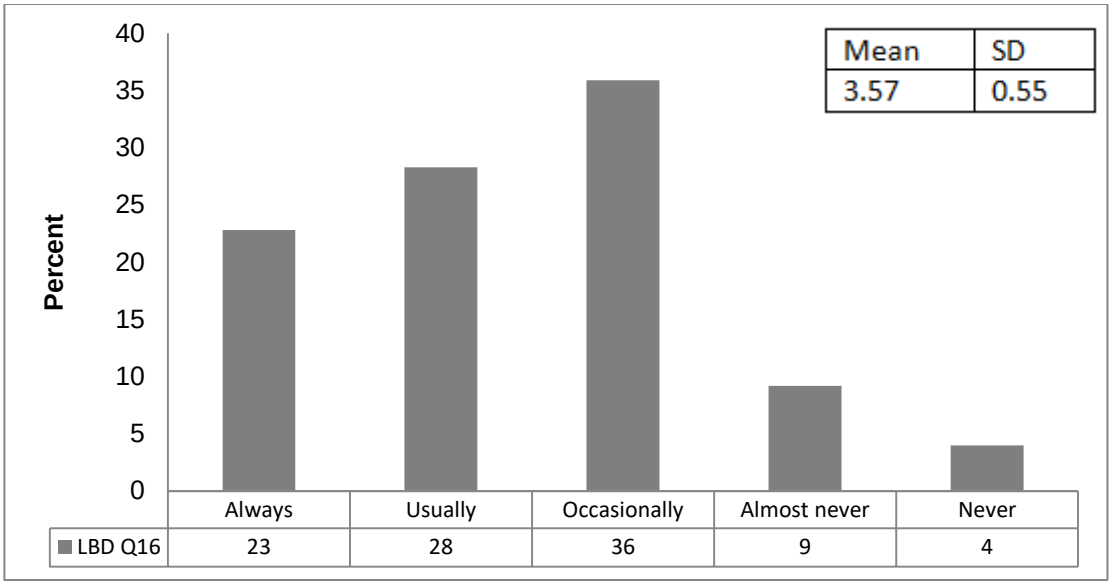


Figure 4.17. Statement 16 LBD practice on using activities that motivate students

The 16th and final statement in the survey sought to assess if the students believed that classroom practice is formulated so that students can be more active and motivated while doing the practice.

As seen in Figure 4.17, 51% of the students believed that the practice that encouraged and motivated the students were being performed. The mean in this statement's data is 3.57 (which is almost similar to the mean of the data set which is 3.59), and the standard deviation is 0.55 (which is less than the SD of the data set at 0.62). The range of the value is 3.57±0.55. These findings highlight that the majority of the students did believe they are motivated and encouraged by the way the classroom practices are aligned and formulated; the SD indicates that most of the responses were scattered between *Occasionally* and *Usually.* However, 13% of students were not encouraged and have answered *Almost Never* and *Never* for this activity on the survey, as can be seen from the graph for this statement's response presented above.

4.2.2. Summary of results for the 16 Learning-By-Doing practices.

Table 4.4 highlights a summary of the LBD survey results. These results are viewed from the student perspective on whether the LBD practices are being

implemented in the classroom. For the sake of simplifying the understanding of these categories, the researcher has assumed that for responses *Always* and *Usually*, the LBD activity can be assumed to be being frequently deployed in the class.

Likewise, for responses *Almost Never* and *Never*, it is assumed that the activity is not used, or is used significantly less frequently.

Table 4.4

Summary of Students' Responses for the 16 LBD Practices

	LBD Practices	Use of the LBD practices perceived to be Frequently implemented	Use of the LBD practices perceived to be infrequently implemented
1	Activities require students to ***collaborate***.	57.6%	16.3%
2	Classrooms are ***interactive***.	63.0%	12.5%
3	Post evaluation of learning activities using ***Q&A***.	57.7%	15.2%
4	Exams ***scenario***. Based on what students have learned in class.	54.9%	14.6%
5	The instructor uses ***real-life*** case studies.	51.1%	16.3%
6	Students are presented with ***problem-based*** questions.	49.0%	16.3%
7	Instructors use **simulation**.	59.8%	9.8%
8	Instructor demonstrates a required ***subject skill***.	65.2%	8.7%
9	Students do ***drills*** and practice.	72.3%	9.3%
10	Students are encouraged to ***reflect***.	54.9%	12%
11	Instructors use ***multiple methods of assessmen***t.	51.6%	18.1%
12	Instructors conduct activities that allow students to ***experience*** the topic.	45.6%	21.8%
13	The college program is linked to ***future*** professional life.	48.9%	19.6%
14	Classroom activities that ask the students to ***model*** experiences or concepts.	50.9%	14.6%
15	Instructors encourage students to ***record*** their impressions.	60.3%	14.2%
16	***Hands-on*** and games activities to motivate students.	51.1%	13%

All the 16 LBD practices listed in the survey are found to be performed by the instructor in their classes at 'frequently' levels by at least 45% of the students. This perception (that any given LBD practice is being implemented frequently), varies between 45.6% (for LBD statement 12, Instructors conduct practice that allows students to experience the topic) and 65.2% (for LBD statement 8, Instructor demonstrates required subject skill). While it is commendable that many students are able to perceive the performance of LBD practice in a relatively large number of instances, there is also cause for concern as many students have also indicated that they think that the practice is not being performed frequently (see column Use of the LBD practices implemented Less Frequently in Table 4.4). When it comes to the specific LBD practice, 'Instructors conduct practice that allows students to experience the topic'; statement 12 stands out as one LBD practice that is not being undertaken, or at least not being perceived by the students to have been frequently conducted by their instructors. This is further affirmed by the fact that only 49% of the students believed that 'Students are presented with problem-based questions' (statement 6). Further, only 54.9% of the students believed that 'Students are encouraged to reflect' (statement 10). Thus implying further that perhaps they are not able to think, assimilate, and interact with the delivered content in a more personal and comprehensive manner. Similarly, only 50.9% of the students perceived that 'Classroom practice that asks the students to *model* experiences or concepts' (statement 14) was being performed. These findings highlight a possible gap in classroom teaching at the target institute – that is, the scope of further engaging students in a more experience-based, interactive, problem and project-based and reflective approach so that they can learn their concepts in a manner that gives them clarity about both theory and application.

The findings also show that 63% of the students perceive that the 'Classrooms are interactive' (statement 2) and 65.2% of the students think that the 'Instructor demonstrates a required subject skill' (statement 8). This suggests the students perceive the instructors as taking an active interest in the class and making an effort to demonstrate the skills, though when combined with the previous findings as just discussed, they perceive to be not receiving adequate chance to reflect, experience and interact with the content themselves. However, it is interesting to note is 72.3% of the

students believed that ‘Students do drills and practice’ (statement 9) which, ideally are expected to give them the experience-based learning as engineering students. Another interesting finding is that 60.3% of the students report that ‘Instructors encourage students to *record* their impressions’ (statement 15), but, again, only 54.9% had stated that they are encouraged to reflect (statement 10). The theme that seems to appear is that the instructors may be incidentally implementing the LBD practice. The underlying goals that these LBD practices are supposed to achieve are not focused upon. For example, the students record their impressions, but they do not understand how to ‘make use’ of this act of recording (ideally, it should have encouraged reflection, analysis of the theory and application more closely). Also, they are performing drills because instructors encourage this, but they do not perceive to be gaining experience or problem-based learning from it. The findings, therefore, suggest that there is a greater need for the instructors to understand the goals or expected outcomes from LBD practice and then to align their efforts toward achieving them. Mere delivery of LBD practice in a mechanical manner may not be sufficient; many students fail to perceive such practice as being delivered, and many, who may perceive their existence, may still not be able to derive full benefits from them.

Another crucial finding was that only 48.9% of the students believed that ‘The institute program is linked to *future* professional life’ (statement 13). This is an extremely important point, as it goes to the state of the students’ mindset and approach toward classroom teaching and impacts their intention and ability to engage with the program. It may also impact their motivation levels as they may not perceive that they are getting the knowledge, skills, or experiences that are going to be useful to them in their future.

4.3. Findings for Research Sub-Question 3

Since the main research question is: “What constructively aligned Learning-By-Doing (LBD) pedagogical model incorporating 21^{s}t Century Skills can be developed for enhancing the teaching of engineering at HCT, UAE?”, it is important to initially explore and evaluate how LBD is currently being practiced and, which 21st Century Skills are being taught and assessed in the classroom. As such, this section deals with

the research sub-question 3: “From the perspective of instructors and students, which 21st Century Skills are taught and assessed in the practice of LBD?”

As students are the recipients of the learning strategies inside the classroom, they are indeed in the position to observe whether particular LBD practices and 21st Century Skills are being delivered as part of the learning strategies. Students were provided with a definition of each skill to understand what was being referred to in the survey’s eleven 21st Century Skills statements. For each skill, participants were asked to provide their perception about how a particular skill was taught and assessed in the teaching and learning environment.

This second survey was administered to the student participants to gather their perceptions about the 21st Century Skills in their teaching environment. As previously discussed in Chapters 1 and 2, 21st Century Skills emphasize global awareness; economic, financial, entrepreneurial and business literacy; civic literacy; and the awareness of health or wellness (Partnership for 21st Century Skills, 2008). In addition, these elements specifically address the Skills required for learning and thinking, including the enhancement of critical thinking and problem-solving skills, creativity and innovation, communication, collaboration, contextual learning, media literacy, and information.

4.3.1. 21st Century Skills survey findings.

To address the students’ responses to the third research sub-question of the study, “From the perspective of instructors and students, which 21st Century Skills are taught and assessed in the practice of LBD?” The surveys, both LBD practices and 21st Century Skills, incorporated all engineering students enrolled during the academic year at the institute at the time of data collection for this study. The 21st Century Skills survey was administered and completed in a 50 minute class time frame so the students were able to observe and recall information to answer the statement responses to the best of their ability. The 21st Century Skills survey was administered to 218 engineering students with 132 responding. Notably, the number of participants was lower than the 184 responding to the LBD survey. This meant that of the total possible student

participants, almost 30% chose not to follow up with the 21st Century Skills survey. However, it was not known if all 30% were from the same 184 students who responded to the LBD survey. The survey statements for 21st Century Skills are listed in Table 4.5. The 21st Century Skills were derived from the reviewed literature discussed in detail in chapter 2.

Table 4.5

Statements from 21st Century Skills Survey

Statements	C21st Skills	Taught	Assessed
1.	Creativity	Instructors encourage me to come up with my original thought rather than copying someone else's idea.	The instructor recognizes my original ideas in the classroom by giving me extra points or positive feedback.
2.	Communication	Instructors conduct practice that requires students to communicate with a group or team to fulfill classroom tasks.	Good communicators are rewarded with academic points and positive feedback.
3.	Collaboration	Instructors conduct classroom practice that encourages interaction among students.	Instructors include collaboration as one of the rubric guidelines for marking a classroom activity.
4.	Teamwork	Instructors encourage teamwork through classroom practice that requires students to work as a group.	Instructors reward teamwork by including it in the rubrics of assessment.
5.	Critical Thinking	Instructors provide practice where students use idea-generating techniques to develop several original ideas for the product(s).	Instructors ask questions from different perspectives to elaborate and improve on the students' idea.
6.	Cultural Sensitivity	Instructors conduct classroom practice that develops an awareness of UAE and other cultures.	A practice that celebrates cultural differences and awareness are conducted as part of the classroom or extra-curricular practice where students' participation is required.
7.	Ethical Behavior	Instructors incorporate and emphasize ethical values in their classroom practice. Examples of these values are honesty, punctuality, and respect.	Ethical practices such as honesty and punctuality affect the grades either by awarding it or penalizing those who don't follow it.

8.	Life Skills	Instructors teach not only intellectual knowledge but how to adapt to society by teaching Skills to use in personal and community life.	Instructors consider students learning needs in the present and for the future.
9.	Problem Solving	Instructors conduct classroom practice that requires students to examine different processes or paradigms and apply them to different types of problems	Projects that are research-based are part of the assessment strategy.
10.	Innovation	Instructors encourage me to develop my ideas and turn them into something practical.	The instructor use classroom practice that provides students the chance to create something new and innovative.
11.	Computer Literacy	The instructor includes IT Skills in teaching to support teaching and learning.	The instructor requires deliverables to be made or developed using the IT Skills learned by the students and includes them as part of the assessment.

The students were presented with statements describing eleven 21st Century Skills in the survey form. From there they were asked to provide their responses on a 5-point Likert scale ranging from *Never*, *Almost Never*, *Occasionally*, *Usually* to *Always*. Table 4.6 (similar to Table 4.2) describes the meaning associated with the components of the frequency scale.

Table 4.6

Explanation of Likert-Scale Used in 21st Century Skills Survey

Scale	Description
5	Always
4	Usually
3	Occasionally
2	Almost Never
1	Never

As was the case with the LBD practices survey, descriptive analysis was carried out by using the percentages, the mean (M) and standard deviations (SD) in order to

determine for each survey statement the average or typical student response to items and to also describe the level of variation of responses within the data set from the mean. Determining the extent to which student responses were dispersed from the average (mean) gives a sense of variability in the data, which can also indicate where a more specific, item-level analysis could be useful. Low standard deviations suggest most of the responses are close to the expected mean, or that they answered within a short dispersion of the mean value. The students' ratings, Mean, and Standard Deviation of survey results for each of the 21st Century Skills are shown in Table 4.7.

Table 4.7

Raw Data, Percentages, Means and Standard Deviations of C21st Skills Survey

			RAW DATA								*PERCENTAGE %*				
Statements	**21st Century Skills**		**Always (5)**	**Usually (4)**	**Occasionally (3)**	**Almost never (2)**	**Never (1)**	**Total Responses**	**Mean**	**Standard Deviation**	**Always (5)**	**Usually (4)**	**Occasionally (3)**	**Almost never (2)**	**Never (1)**
1	**Creativity**	Taught	11	20	35	50	16	132	2.70	0.25	8.3	15.2	26.5	37.9	12.1
		Assessed	7	16	38	38	33	132	2.44	0.23	5.3	12.1	28.8	28.8	25.0
2	**Communication**	Taught	27	31	28	38	8	132	3.23	0.34	20.5	23.5	21.2	28.8	6.1
		Assessed	6	20	34	36	37	132	2.39	0.21	3.8	15.2	25.8	27.3	28.0
3	**Collaboration**	Taught	7	32	31	34	28	132	2.67	0.28	5.3	24.2	23.5	25.8	21.2
		Assessed	6	25	52	36	13	132	2.81	0.39	4.5	18.9	39.4	27.3	9.8
4	**Team Work**	Taught	27	38	33	29	5	132	3.40	0.40	20.5	28.8	25.0	22.0	3.8
		Assessed	12	25	39	31	25	132	2.76	0.25	9.1	18.9	29.5	23.5	18.9
5	**Critical Thinking**	Taught	1	8	50	43	30	132	2.30	0.39	0.8	6.1	37.9	32.6	22.7
		Assessed	6	21	48	34	21	130	2.67	0.34	4.6	16.2	36.9	26.2	16.2
6	**Cultural Sensitivity**	Taught	5	19	19	56	29	128	2.34	0.25	3.9	14.8	14.8	43.8	22.7
		Assessed	10	14	36	41	31	132	2.48	0.20	7.6	10.6	27.3	31.1	23.5
7	**Ethical Behavior**	Taught	40	48	22	18	4	132	3.77	0.61	30.3	36.4	16.7	13.6	3.0
		Assessed	37	35	34	12	14	132	3.52	0.30	28.0	26.5	25.8	9.1	10.6

8	**Life Skills**	Taught	15	19	42	34	22	132	2.78	0.25	11.4	14.4	31.8	25.8	16.7
		Assessed	10	20	63	26	12	131	2.92	0.46	7.6	15.3	48.1	19.8	9.2
9	**Problem Solving**	Taught	15	18	41	45	11	130	2.85	0.28	15.1	13.8	31.5	34.6	8.5
		Assessed	8	29	55	29	8	129	3.00	0.44	6.2	22.5	42.6	22.5	6.2
10	**Innovation**	Taught	12	34	32	32	21	131	2.88	0.29	9.2	26.0	24.4	24.4	16.0
		Assessed	13	20	42	39	17	131	2.80	0.30	9.9	15.3	32.1	29.8	13.0
11	**Computer Literacy**	Taught	19	43	34	26	10	132	3.27	0.41	14.4	32.6	25.8	19.7	7.6
		Assessed	31	42	40	15	4	132	3.61	0.5	23.5	31.8	30.3	11.4	3.0

As observed in Table 4.7, the Mean values of all eleven 21st Century Skills taught and assessed variables ranged from 2.30 to 3.77. In the Means column, statement 7, which deals with ethical behavior, has the highest mean for both taught and assessed in comparison to the other 10 Skills. Furthermore, the SD for this skill, in both categories – taught and assessed, is over 0.5, which is the highest of all standard deviations. It is also noted that when looking at the responses for 'taught' versus 'assessed', there is often a considerable variation in what is being taught and how students see this as being assessed. For example, statement 2 reflects a considerable difference in how the students perceive what is being taught when compared with how it is being assessed.

Furthermore, when considering the SD in the context of these responses, the fact that the SD is less than 0.4 suggests that data points are not scattered widely across the scale. Rather they are clustered around the mean value. This indicates that most of the students responded around the mean value, and few, if any, responded toward the extremities (*Always* or *Never*).

4.3.2. Item-level findings of the 21st Century Skills data.

The data gathered from the 21st Century Skills survey further provided insights on how each skill is taught and assessed from the students' perspectives. This section contains a graphical representation of the frequency of the responses on each skill, using both categories – taught and assessed. This is followed by a discussion of the findings, and interpretation and analysis of the means and SDs.

1. Creativity

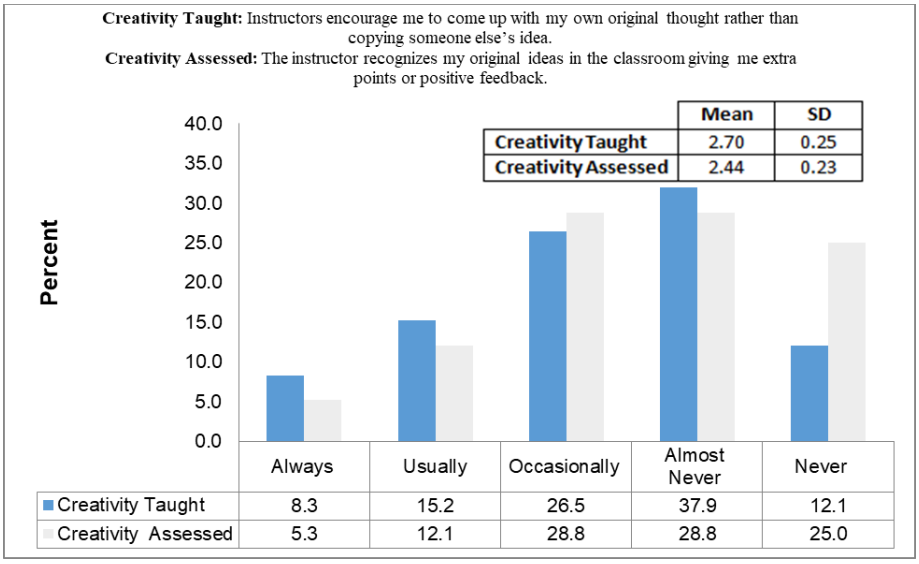


Figure 4.18. Statement 1 C21st Skill Creativity is being taught and assessed

The first statement in the survey addressed the students' perception of whether creativity was being taught and assessed. As per the college guidelines, it is mandated that instructors apply the 21st Century Skills in lessons. This would mean that the instructor would encourage the student to think outside-the-box; showing them different ways of looking at, solving or addressing a problem in different situations. From the assessment point of view, the assessment portion of this question noted whether or not the instructor then assessed the students in their activity as having used creativity within the learning experience itself. The assessment portion of this skill is important if the student is to learn self-evaluation skills, as well as to know if they are applying creativity most effectively.

As observed in Figure 4.18, under the creativity skill being taught, 23.5 % responded with the perception that this skill was being taught *Always* or *Usually*. This is a relatively low response, especially when considering that even when adding in the 26.5% of responses showing that the activity took place *Occasionally*, the overall response is 50%.

The mean in this statement's data is 2.70. The standard deviation is 0.25, which is very low, indicating that the dispersion of the responses is very limited, and most

respondents answered around the mean or *Occasionally* and *Almost Never* categories. The responses lay in the range 2.7±0.25. Since the mean of this statement is centered around the response category *Occasionally*, and a small SD of 0.25 shows little variation in the responses, it indicates that most respondents marked around *Occasionally*.

In comparison, the data compiled under the skill being assessed shows that 17.4% responded that the activity took place in the *Always* or *Usually* category. When combined with *Occasionally* responses (28.8%), this brings it to 46.4 .1% of the students perceiving that the skill was being assessed at least occasionally. It is indicative of the fact the students perceived that their instructor taught the skills of Creativity more than they assessed it.

The students' response to this question would lie between 2.44±0.23 or around *Never*. This means indicates that overall, the students think that instructors are less inclined to assessing their creative ability.

2. Communication

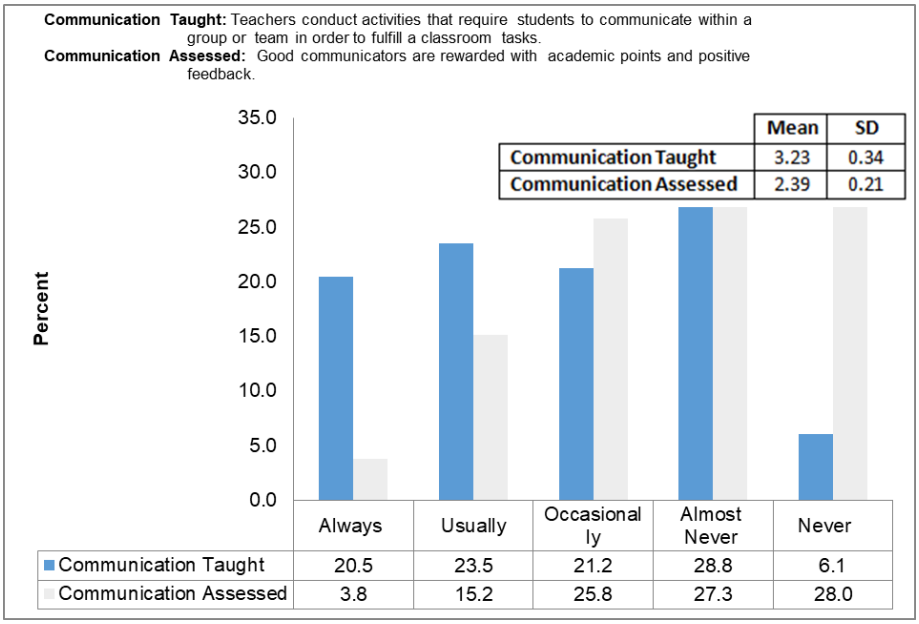


Figure 4.19. Statement 2 C21st Skill Communication is being taught and assessed

The second statement in the survey addressed the students' perception of whether the communication skill was being taught and assessed during the course of the

program. Communication comes in the form of people skills, whereby individuals articulate their explanations, points of view, critiques and the like. From the teaching point of view, the instructor is expected to teach through instruction and modeling how communication skills are used in learning and practical experiences. From the assessment point of view, the assessment portion of this question noted whether or not the instructor then assessed the students in their activity as having used communication skills within the learning experience itself. The assessment portion of this skill is important if the student is to learn how to successfully communicate in the business world.

As seen in Figure 4.19, under 'Communication taught', 44% responded with this happening *Usually* or *Always* in the class. Combined with the responses on *Occasionally*, this comes to 65.2%. The Mean is at 3.23 and standard deviation is 0.34. The range lies within 3.23±0.34 as per the responses received. The SD findings indicate that the skill is being taught *Usually* or *Occasionally* as perceived by the majority of the respondents and that only and some of the students may have responded *Almost Never.*

In comparison, the data compiled under the skill being assessed shows the reverse response, with 19% responding that the activity took place *Always* or *Usually*. This indicates a low response to this statement, especially when 55.3% of the participants rated this activity happening *Never* or *Almost Never*. The Mean value is 2.39, and SD value is 0.21. The value of students' responses to this question would lie between 2.39±0.21. This indicates that most students perceived this skill as not part of their assessment (or most students had selected a choice between *Usually* and *Almost Never*). These findings reveal that while the majority of the students believed that this skill was being taught; they did not believe that it was being assessed.

3. Collaboration

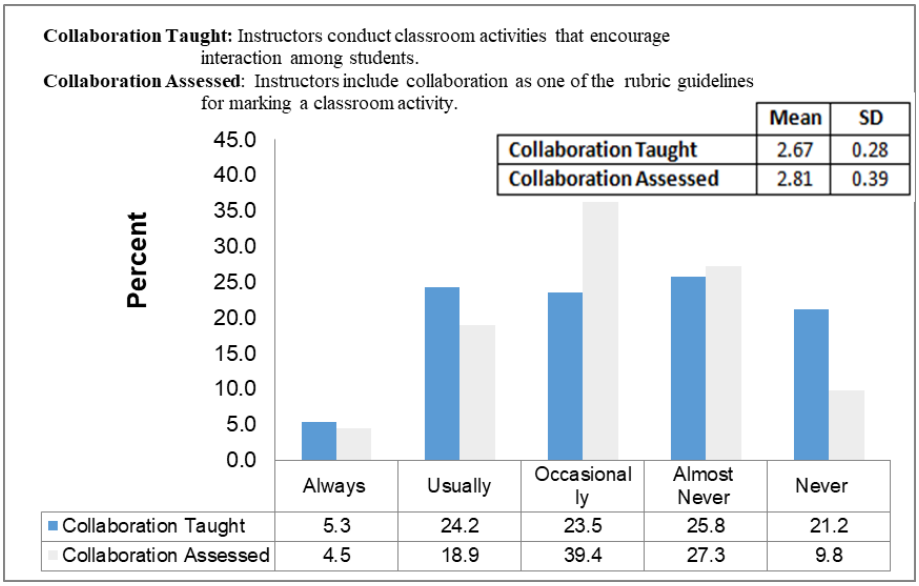


Figure 4.20. Statement 3 C21st Skill Collaboration is being taught and assessed

The third statement in the survey addressed the students' perceptions of whether collaboration was being taught and assessed within the lesson format. Collaboration within the lesson is to help the students develop team-building skills, whether working in pairs or in small or large groups. It can also foster and aid the development of communication skills, as when an individual has to work with others and "collaborate" to fulfill a purpose, then they need to use many of the 21st Century Skills mentioned. From a teaching point of view, the instructor needs to provide activities which will require students to work together. This will help them to develop team-building skills for future employment.

As seen in Figure 4.20, under the question of collaboration being taught, only 29.5% responded this as happening in categories *Always* and *Usually*. With the data for *Occasionally* category added, this comes to 53%. This shows 53% of the students see themselves as using collaboration in learning activities at least occasionally. However, 47% of the students noted collaboration occurred in the *Almost Never* or *Never* categories. The mean value is 2.67, and the SD value is 0.28. The responses fall in the range of 2.67±0.28, or between *Occasionally* and *Almost Never* indicating that the

majority of students believed they were either being taught the Collaborative skills in the *Occasionally* to *Almost never* range.

The data compiled under the question of collaboration being assessed show a low rate of 23.4% in the *Always* and *Usually* range. This is overshadowed by the responses where students interpreted they were only assessed *Occasionally* on the Collaboration skill (38.4%); the mean value is 2.81, and the SD is 0.39. This indicates that in terms of assessment of collaboration, the average value is less than 3, that is, Collaboration assessment takes place less than *Occasionally*. The responses range within 2.81±0.39 or between *Occasionally* and *Almost Never*. The findings are indicative of the fact that the skill is perceived by the respondents as being neither taught nor assessed as frequently as mandated by the school curriculum.

4. Team Work

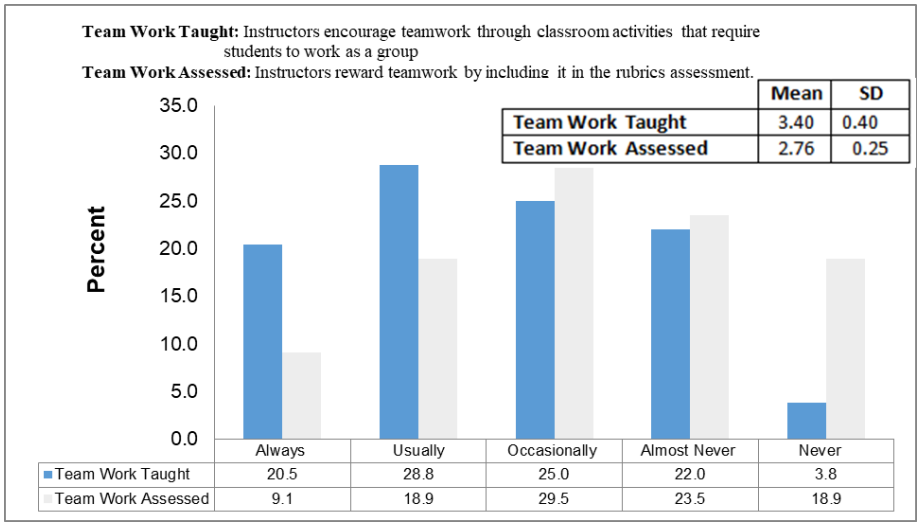


Figure 4.21. Statement 4 C21st Skill Teamwork is being taught and assessed

The fourth statement in the survey addressed the students' perception of whether teamwork was integrated into the course work and their learning practice and assignment. Teamwork is expected to involve Collaboration (see third statement in Figure 4.20) to practice workplace skills of working in groups or teams to accomplish a set goal.

As seen in Figure 4.21, under the statement of Teamwork being taught, 49.3% perceived this to be happening in the class *Always* or *Usually*. When combined with *Occasionally* responses, the addition to this category brings the responses to 73.8%. The responses lie within the range of 3.4±0.4, implying that in teaching Teamwork Skills, the majority of the respondents perceive it as being taught *Occasionally* or *Usually*.

In comparison, the data compiled under the statement of Teamwork being assessed shows the reverse response, with only 28% responding that the activity took place in the *Always* and *Usually* categories. The different perceptions between what is being taught and what is being assessed during the program indicate there is scope for discussion in this study.

The SD of 0.2, along with the mean of 2.76 for this set of data implies that a maximum number of responses ranged between 2.76±0.2. This means that the mean value centered at 2.76 and most responses reflect most responses were in the *Almost Never* and *Occasionally* categories. These findings showcase the fact that while this Teamwork skill is perceived as being taught in class, it is not perceived as being assessed.

5. Critical Thinking

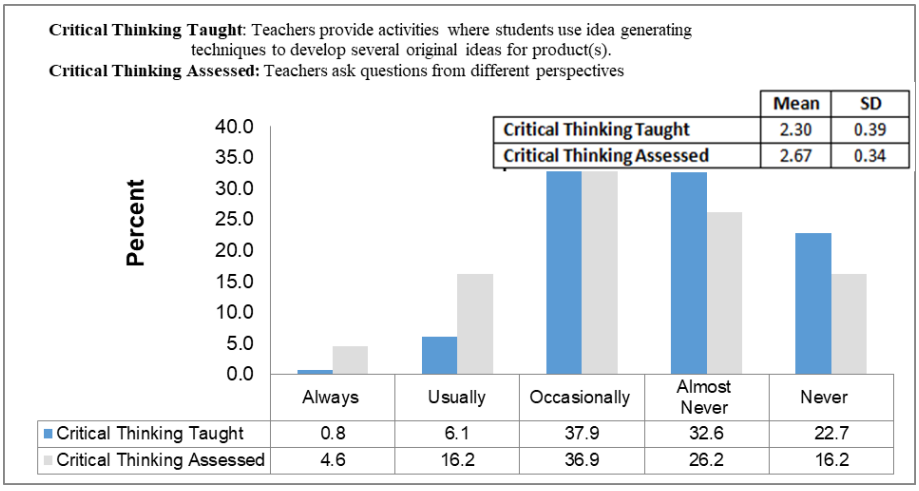


Figure 4.22. Statement 5 C21st Skill Critical Thinking is being taught and assessed

The fifth statement in the survey addressed the students' perceptions of whether Critical Thinking was taught as part of the course, and if the students were being assessed by the instructor which might include asking questions that permitted them to critically assess their responses to show how they came about their findings. The 'skill taught' portion of this statement focused on the instructors' abilities to teach and show students how to use different methods to come to the final answer via Critical Thinking. The 'skill assessed' portion of the statement established the reliability of the instructor in applying a feedback questioning method that fostered Critical Thinking Skills in students.

As seen in Figure 4.22, there is a lower percentage of students who believed that the teaching of Critical Thinking Skills was being undertaken *Always* or *Occasionally.* In the survey conducted, it was found that only 6.9% responded as this skill is being taught in the *Always* or *Usually* categories. This was different for the *Occasionally* category, where 37.9% of the students responded that Critical Thinking Skills were used during teaching lesson. Most notably, the *Almost Never* and *Never* categories were chosen by 55.3% of the student participants, which reflected that the majority of the students believed that Critical Thinking Skills were rarely taught. The mean in this statement's data is 2.30, and the standard deviation is 0.39. These values indicate that the mean value for critical thinking is lower than 3 (which is for the *Occasionally* response), with a dispersion larger than those for some other questions. The range of values for this is 2.30±0.39. These findings indicate that the majority of the students did not believe that they were being taught critical thinking Skills (as they largely selected between almost never and never categories).

In comparison, the data compiled under the skill being assessed indicates that the students perceive they are being assessed on the use of Critical Thinking Skills more than they are being taught Critical Thinking Skills. *Always* and *Usually* categories had a combined result of 20.2%, while *Occasionally* has the most responses, over one third, with 36.9%. However, inversely 42.4% of the students, chose *Never* and *Almost Never* categories. The mean in this statement's data is 2.67, and the standard deviation is 0.34, indicating the responses were concentrated around 2.67 and dispersed around it by

±0.34. Again, these findings indicate that the majority of the students did not perceive that they were being assessed on their Critical Thinking Skills.

6. Cultural Sensitivity

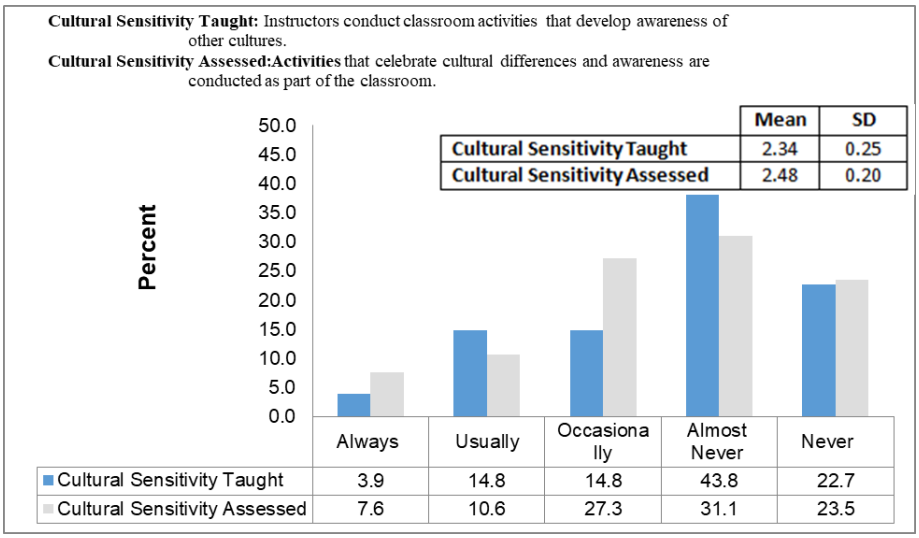


Figure 4.23. Statement 6 C21st Skill Cultural sensitivity is being taught and assessed

The sixth statement in the survey addressed the students' perception of whether the instructor's use of practice helped to develop a learning environment that paid attention to the similarities and differences between cultures. In our vast and diverse new world of international commerce and social interactions, cultural awareness is a high priority of anyone working in any industry, as all people are affected by the globalization of our 21st Century world.

Figure 4.23 shows results that indicate 18.7 % of the respondents of the survey answered that Cultural Sensitivity Skills were being taught to them, either *Always* or *Usually*. Furthermore, if one were to combine the *Occasionally* category, with this response, then it can be seen that 33.5% of the respondents perceived that Cultural Sensitivity was taught at least occasionally. Most notably, the *Almost Never* and *Never* categories rated highest, with 66.5% of the student participants believing that Cultural Sensitivity Skills were not being taught. The mean in this statement's data is 2.34, and the standard deviation is 0.3, indicates that the dispersion of data is around 2.34 ±0.3, or between *Occasionally* and *Almost Never*. The students have, therefore largely indicated that they are *Almost Never* being taught this skill.

In comparison, the data compiled under the skill being assessed indicates that the students' perceive they are assessed on the use of Cultural Sensitivity Skills relatively

more than they are being taught. The response of the *Always* and *Usually* categories is 18.2%, while *Occasionally* has the most responses with 27.3%. However, the *Almost Never* and *Never* responses are high, at 54.6% for assessment of Cultural Sensitivity Skills. The mean in this statement's data is 2.48, and the standard deviation is 0.20. In other words, it implies that most students believed they were being assessed *Almost Never* or *Occasionally* on this skill.

7. Ethical Behavior

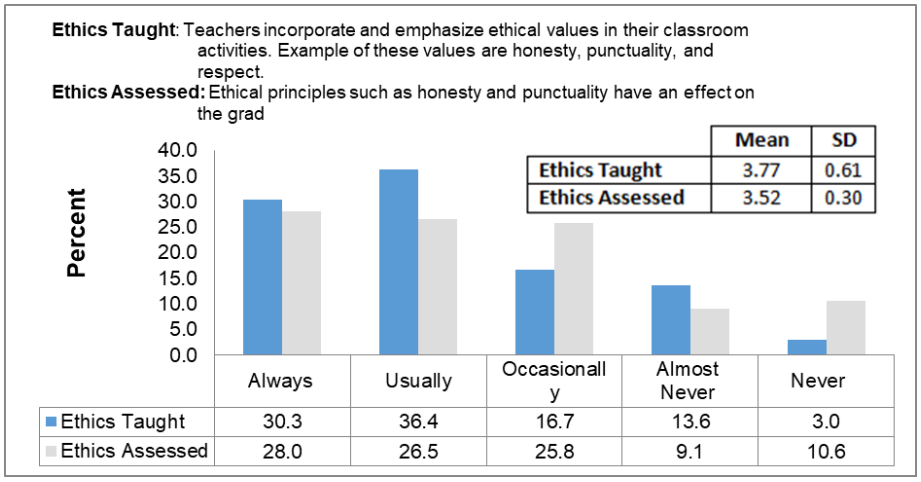


Figure 4.24. Statement 7 C21st Skill Ethical practices are being taught and assessed

The seventh statement in the survey addressed the students' perception of whether ethical values and practices were not only taught in the class, but also whether or not there was a known expectation of what ethical behavior would or would not be accepted in the classroom. This is what might be referred to as "common decent behavior" where everyone in the classroom is expected to treat each other with the same respect that they have a right to expect for themselves. This includes honesty, punctuality, and fair treatment of others; it also includes being Culturally Sensitive (see statement 6). From the assessment point of view, the assessment portion of this statement means that the students are aware that their classroom behavior as well as ethical considerations with their study experiences, in response to the class's ethical expectations will affect their grades.

As seen from Figure 4.24, under skill being taught, 66.7% of the students believed that this skill was being taught either *Always* or *Usually*. If you factor in the *Occasionally* category, then 83.4% of the students perceive that it is being taught at least *Occasionally*. The *Almost Never* and *Neve*r responses to this statement were quite low, at just 16.6% of the students choosing them. The mean in this statement's data is 3.77, with a standard deviation of 0.61. Notably, this standard deviation is the largest of all the standard deviations seen in this survey's responses. A higher standard deviation means the data collected for the said referenced statement has a wider range of responses, and it could be indicating that the respondents might be showing some confusion on how the statement was interpreted or that there is a broader range of perceptions about whether or not this skill is being taught/assessed. However, since the mean is 3.77, implying that the majority opted for between the *Occasionally* and *Usually* categories, a SD of 0.61 would place the majority of responses between *Usually* and *Occasionally*. Thus, the majority of the respondents do appear to perceive that the skill is being taught.

Similarly, the data compiled under the skill being assessed shows that 54.5% of the students believed that the assessment of Ethical behavior took place in the class. When combined with the *Occasionally* responses, this brings the potentially positive responses to 80.2%. Only 19.7% of the students have responded with *Never* and *Almost Never*. The mean in this statement's data is 3.52 with the standard deviation of 0.30, meaning that the range of the responses for this question is within 3.52±0.30. Notably, although this standard deviation is one of the highest of all standard deviations seen in the survey, it still appears to imply that most students believed they were being assessed on this skill.

8. Life Skills

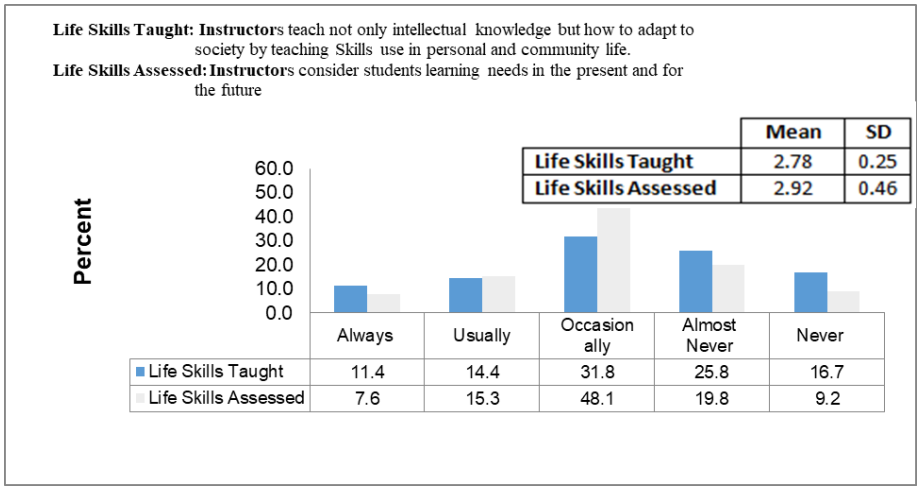


Figure 4.25. Statement 8 C21st Skill Life Skills are being taught and assessed

The eighth statement in the survey addressed the students' perception of whether Life Skills were incorporated into teaching and if the coursework involved lessons and practice that used Life Skills in both theoretical and practical applications. This would imply that the students would be able to use what they have learned for application in their practical life experience. The taught portion of this skill is important as it helps the students to value the real world in the context of the knowledge-gaining studies.

In Figure 4.25, under skill being taught, only 25.8% responded positively to this as occurring either *Always* or *Usually*. When adding the *Occasionally* category responses, the overall potential positive response is 57.6%. The mean in this statement's response data is 2.78 with the standard deviation at 0.25, which means that the responses are within the ranges 2.78±0.25. This again implies that almost half of the respondents believe that they were not being taught this skill.

The data compiled under the skill being assessed shows a similar response for the *Always* and *Usually* categories, with the taught and assessed being 25.8% to 22.9% respectively. It is the *Occasionally* and the *Almost Never* and *Never* categories where a difference occurs. While the *Occasionally* taught category is 31.8%, assessed is 48.1%. This reveals the perception that more students' believe that assessment on this skill occurs more frequently than it is being taught. For *Almost Never* and *Never* taught is

42.5%, whereas the assessed is 19.8%. This again implies that the students perceive they are a being assessed more on these Life Skills in comparison to what is being taught.

9. Problem Solving

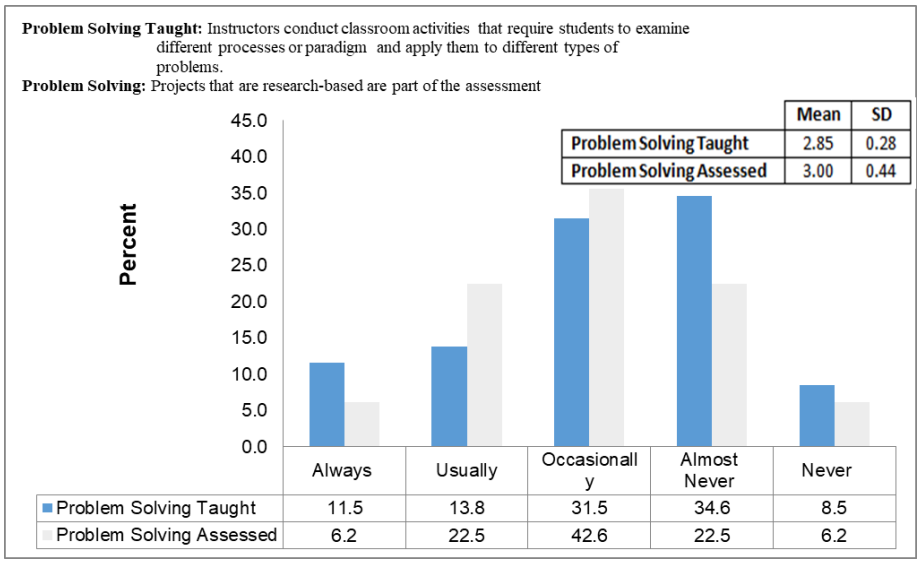


Figure 4.26. Statement 9 C21st Skill Problem-solving Skills are being taught and assessed

The ninth statement in the survey addressed the students' perception of whether or not the instructor used different processes or paradigms to help in the solving of different types of problems. Problem-solving Skills are imperative in the work environment to solve 'real world' problems that an engineer might encounter, no matter the field of study. Problem-solving Skills work with both Critical Thinking Skills (see statement 5) and with Team Work (see statement 4). Problem-solving Skills are the foundation from which any solution to a problem can be sought and built upon. Under the skill taught option, it is explored if the instructors give a demonstration of how to solve a presented problem, and if they put in guidelines for the students to use problem-solving techniques in any assignment or task given. From the assessment point of view, it is determined whether or not the instructor then assessed the students as having used Problem-solving Skills within the learning experience itself.

Figure 4.26 shows that 25.3% responded *Always* or *Usually* for the skill taught statement. In combining these responses with the *Occasionally* category, the percentage of students comes to 56.8%. This is almost balanced out by the responses of *Almost*

Never and *Never*, with this combined category receiving a 43.1% response. The mean for this statement is 2.92 and the standard deviation is 0.46 which means that the responses would be between 2.92±0.46. This can be interpreted as more than half of the students believing that the skill was being taught.

The data compiled under the skill being assessed show a similar response to the *Always* and *Usually* categories with the taught and assessed being 25.3% to 28.7% respectively. It is again the Occasionally, the *Almost Never*, and *Never* categories where a difference occurs. While under *Occasionally* taught is 31.5%, assessed is much more at 42.6%. For *Almost Never* and *Never* combined, taught is 43.1%, assessed is 28.7%. This result appears to indicate that more students perceive they are being assessed on these Problem-solving Skills in comparison to what is being taught. The mean in this statement's data is 3.0 and with the standard deviation at 0.44, the responses are largely dispersed between 3.44 and 2.56 or around *Usually* and *Almost Never*. When noted with the fact that more than half of the students believed that the skill was being taught between *Occasionally* or *Usually*, it can be read that the majority of the students thought the skill was being assessed more but taught less.

10. Innovation Skill

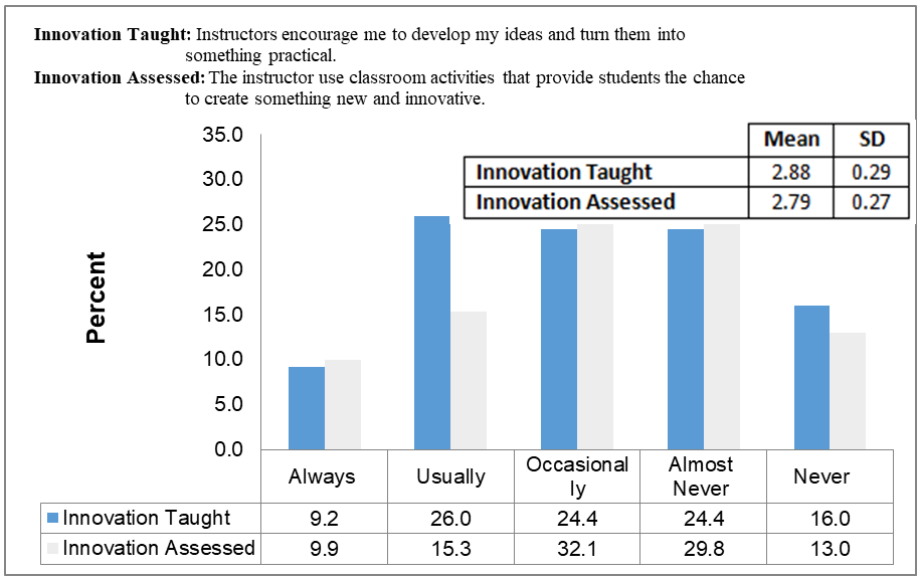


Figure 4.27. Statement 10 *C21st* Skill Innovation Skills are being taught and assessed

The tenth statement in the survey addressed the students' perception of whether the instructor encouraged the students to develop their ideas and then to apply them practically to the problem or assignment presented. Innovation is a valuable competency in knowledge societies. In the fast-paced modern global marketplace, innovation is what makes or breaks a company. The student needs to understand the value of innovation in their future career tasks and as such, through their training must learn how to be innovative, what innovation means to the corporate world's success and how this innovation can be used in various situations of time, place, task and solution.

The teaching portion of this statement addresses whether the students perceive the instructors to be open to the student's ability to try something new or to learn through failure. The assessment portion of this skill is important because students need to understand if what they are doing is innovative thinking.

Figure 4.27 shows that 35.2% responded positively that the skill was being taught in class either *Always* or *Usually*. When adding in the 24.4% of responses from the *Occasionally* category, it is found that 59.6% of the students believed that the skill was being taught at least occasionally. However, 40.4% of the respondents believed that this skill was *Never* or *Almost Never* being taught. The mean in this statement's data is 2.88. The standard deviation is at 0.29, which implies that the responses are dispersed between 2.88±0.29. These findings show that largely, the respondents are fairly evenly spread in their perceptions from *Usually* to *Almost Never*.

In comparison, the data compiled under the skill being assessed shows that 25.2% of the students perceived the skill to be assessed either *Always* or *Usually,* in contrast to the 35.2% of the students who believed it to be taught either *Always* or *Usually*. The reverse is true for the *Occasionally* category, with it being mentioned as taught occasionally by 24.4%, while being mentioned as assessed by 32.1%. The highest responses remain under the *Almost Never* and *Never* categories for the skill being assessed statement which seems to imply that this skill was under assessed. The mean in this statement's data is 2.80 and the standard deviation is 0.30, which implies that responses largely varied between 2.80±0.30, or around *Occasionally.*

11. Computer Literacy

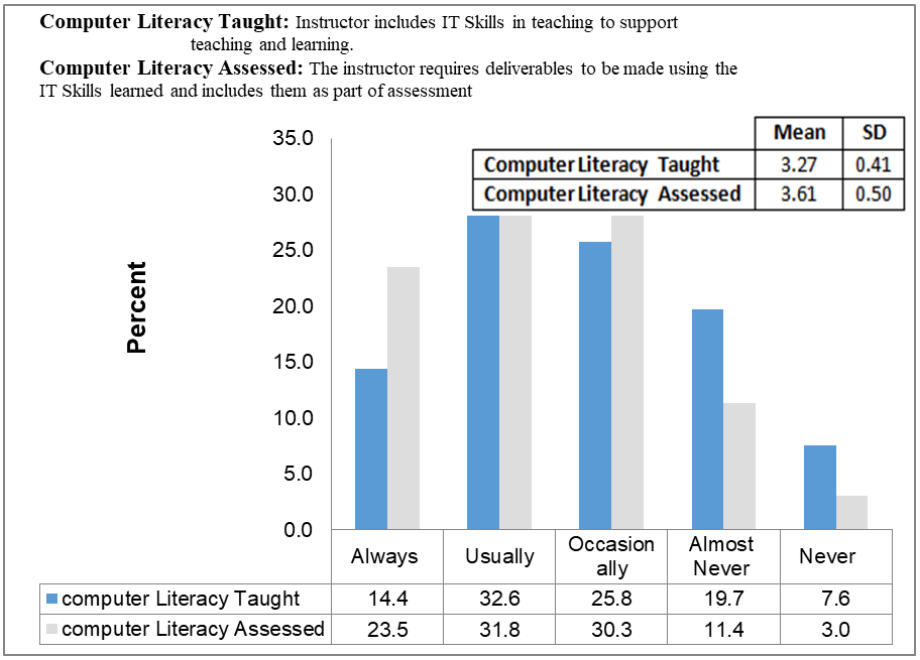


Figure 4.28. Statement 11 C21st Skill Computer literacy

The eleventh statement in the survey addressed the students' perceptions of whether or not they perceived that computer literacy was being incorporated in the lecture, practice, and assessment portions of the course. For this statement, IT Skills include the use of such statements as online videos, the Internet, computer applications like PowerPoint, and any IT Skills that the student might use in their engineering careers. The pedagogical framework here is to teach by showing, and demonstrating how computer programs and applications are run. This could be done via practically showing by working on the system, or via multimedia presentations that give the steps of operating a program or an application. From a teaching point of view, the students were to consider if their instructor enabled them to use IT Skills effectively. From the assessment point of view, the evaluation portion of this question noted whether or not the instructor required their students to use the demonstrated and taught methods of IT skill usage in their practice and assignments.

Under the skill being taught in Figure 4.28, the positive response is given by 47% of the students for the *Always* and *Usually* categories. If you factor in the *Occasionally* category, then the students positive response rises to 72.8%. A relatively lower response

of 27.3% of the students responded either *Almost Never* or *Never*. The mean in this statement's data is at 3.27 and with the standard deviation at 0.41, this indicates that the majority of the responses would be scattered around 3.27±0.41, or across *Usually* and *Occasionally*.

In comparison, the data compiled under the skill being assessed shows that students perceive they are being assessed on computer literacy 55.3% of the time which is higher than the percentage of students who perceived it as being taught (which is 47%). Again, in the *Occasionally* category, more students perceived they are being assessed than those who perceived that they are being taught the computer literacy Skills. This indicates that, overall, the students see themselves as being taught the skill less than they are being assessed on it. The mean in this statement's data is at 3.61. The standard deviation is at 0.50 which implies that the responses would be dispersed between 3.61±0.50, or across *Usually* and *Occasionally*. The reasons for different perceptions about taught and assessed could be that some students, being a digital natives, don't expect to be assessed on ICT skills.

Notably, this standard deviation is one of the higher deviations out of all standard deviations seen in the survey statements' responses and indicates that students have varied considerably in their choice of response.

4.3.3. Summary of results for the 21st Century Skills.

This section develops an understanding of the relative differences between the implementation of the 21st Century Skills by the instructors. Table 4.8 illustrates an understanding of the 21st Century Skills, as perceived by the students, being implemented most frequently in the classroom (*Always* and *Usually*). It is possible that this table also provides insights about the importance of the skill as noted by the percentage of students who perceived it as being taught/assessed either *Always* or *Usually*. It also contrasts the percentage of students who thought it was being taught and who thought it was being assessed.

Columns 3 and 4 in Table 4.8 are based on the addition of "*Always*" and "*Usually*" in all 11 of the above 21st Century Skills. In Table 4.8, as well as in the discussion of the 21st Century Skills in the next section, *Always* and *Usually* categories have been combined to provide an overall frequency occurrence.

Table 4.8

Summary of Students' Responses for the 21st Century Skills

C21st Skills List	C21st Skills Most frequently Taught	C21st Skills Most frequently Assessed
Creativity	23%	17%
Communication	43%	19%
Collaboration	29%	20%
Teamwork	49%	28%
Critical Thinking	7%	21%
Cultural Sensitivity	19%	19%
Ethical Behavior	67%	55%
Life Skills	25%	23%
Problem Solving	26%	28%
Innovation	35%	25%
Computer Literacy	47%	55%

The survey findings related to the 21st Century Skills have brought into focus numerous insights about how the Skills are being implemented. A theme that is evident is the low percentage of students reporting that any given skill is being taught or assessed either *Always* or *Usually* (or rather, most frequently) in their classrooms. For example, only 7% of students believed that the skill Critical Thinking is being taught most frequently in their class (and only 21% perceived that they were being assessed most frequently on this same skill). This trend seems to permeate the responses to many of the Skills (see Table 4.7). Ethical behavior is perceived as being taught most frequently by 67% of the students only, and it is the highest percentage for the entire set of 21st Century Skills. This implies that for most of the 21st Century Skills, very few have been perceived by more than 30% of the students as being taught most frequently (these include – Ethical behavior Skills (67%), Computer Literacy (47%), Communications (43%), Innovation (35%), Team Work (49%)). In the same manner, even fewer Skills have been perceived by more than 30% of the students as being assessed most frequently (these include – Ethical behavior (55%) and Computer Literacy (55%) only). The findings underline an issue that could be inferred as both a lack of clarity on how the Skills are to be taught and in what measures (since, most students appeared to be unable to perceive that these Skills are being taught most frequently), and how and when to assess the students on the same Skills (since, again, most students failed to appreciate that they were being assessed most frequently on these Skills).

Another theme that has emerged is that there is an apparent disconnect between the students' perceptions about the frequency with which the Skills are taught and with which the Skills are assessed. This works in two ways. One is that a large percentage of students perceive a skill as being taught frequently, but a lesser percentage of students perceive the same skill as being assessed as frequently. What this might be inferring is that students may be thinking that what is being taught is not important or needed during their assessments. Hence, it may lead them to not pay much attention to this skill and lower their motivation to learn that particular skill into their skill set. Examples of such Skills include – Ethical Behavior, Computer Literacy, Communications, Innovation,

Collaboration, Team Work, and Creativity (See Tables 4.7 and 4.8). A second disconnect seems apparent where the students perceive they are being assessed on a particular skill, like Critical Thinking, but, they also perceive that this skill is not being equally taught. In both these cases, when the students perceived that they are being taught the skill but not being assessed, and when they think they are being assessed on a skill but not being taught, the underlying reasons could be many. There could be a lack of clarity amongst instructors on how to teach and how to assess the Skills – thus pointing to the need for an improved curriculum and instruction design model for the institute; or, there could be an inherent intangibility to the skill, which makes it difficult for the instructors to teach or assess. This reason is further explored in the interviews of the instructors and presented in the next chapter in detail.

In addition, Skills like Problem Solving, Life Skills, and Cultural Sensitivity are perceived to be taught as well as assessed frequently by almost a similar percentage of students, indicating that there is some sort of balance in these cases between taught and assessed aspects of the Skills. However, what is interesting to note in this case is the lower percentages of students who have agreed that these Skills are taught and assessed frequently. For example, 26% of students believed that the skill Problem Solving is being taught frequently, and 28% of them believed it was being assessed too. A similar pattern appears for Life Skills (25% of students believed that this skill is being taught frequently and 23% of them believed it was being assessed too) and Cultural Sensitivity (19% of students believed that this skill is being taught frequently and 19% of them believed it was being assessed too). So, while there is balance between teaching and assessment in these cases, it also appears that these Skills are neither taught nor being assessed frequently in the classrooms.

4.4. Summary

This chapter included the presentation of the data compiled from two surveys administered to electrical and electronics engineering students registered at the institute during the academic year at the time of this data collection. The first survey, the Learning-By-Doing (LBD) practices, provided surveys to 218 students with 184 of them

completing the instrument. Likewise, the second survey, 21st Century Skills, provided to the same 218 students resulted in 132 students completing the second survey. As it pertains to the LBD results, students found that the instructors did, for the most part, create an interactive (LBD statement 2) classroom where students were encouraged to write down their impressions (LBD statement 15), while instructors were perceived as demonstrating (LBD statement 12) what activity was to be done. However, LBD statements 12 and 13 suggest the students found that the application to "real life" was missing in the lessons. Primarily, they did not realize "real world" experiences, such as field trips, nor did they see a connection between academic learning and "real world" job experience.

The findings from the 21st Century Skill survey revealed some important themes on how the skills are being assessed and taught in the classroom. Very few skills have been perceived as being taught or assessed most frequently (less than 30% of respondents). Another theme that has emerged is the disconnect between the students' perceptions about the frequency with which the skills are being taught and assessed. In addition, some skills are perceived to be assessed more than taught, and some are taught more than assessed. Therefore, there appears to be an imbalance between teaching and assessment as perceived by the students.

The next chapter discusses further the perceptions of the dean and the instructors about which LBD practices are being implemented in the classroom and which 21st Century Skills are being taught and assessed in the classroom.

CHAPTER 5: QUALITATIVE DATA PRESENTATION AND ANALYSIS

5.1. Introduction

This chapter presents and analyzes the study's qualitative data, which were collected using semi-structured, one-on-one interviews conducted with the two groups of target respondents – engineering instructors and the dean of the program. The one-on-one interview responses address research sub-questions 1-3:

1. What are the current understandings of LBD from the viewpoint of the dean of engineering and the instructors?
2. From the perspective of instructors and students, which LBD practices have successfully been implemented in the engineering department?
3. From the perspective of the dean, instructors, and students, what 21st Century Skills are taught, learned, and assessed in the practice of LBD?

This study uses data collected from the Bachelor of Applied Science (BAS) engineering programs at HCT for Emirati citizens. HCT, being considered in the top three of higher education institutions supporting engineering programs in the UAE, provides useful insight into the experience of similar institutions in the Emirates. This means that when reflecting upon how LBD practices and 21st Century Skills are employed within the learning environment and throughout the engineering programs, the specific findings of this study might cast a broader light on the perspectives and practices of similar universities and their engineering programs in the UAE.

5.2. The Interviews

As outlined in Chapter 3, the college dean and a total of eight engineering instructors at HCT were interviewed. The instructors were employed full-time and delivered 20 hours of engineering courses each week. All the interview questions were

generated from the literature review, and all ethical protocols and considerations were followed in the interview process.

The interviews, which were conducted individually and face to face, were recorded and subsequently transcribed verbatim to text. These texts were reviewed and sorted to provide a framework for organizing the emergent themes.

This process involved multiple readings of the data and coding, which allowed the researcher to take different sections of text from the data and classify them under appropriate themes to bring greater clarity and organization to the study. These themes were identified by using the actual words of the participants.

5.2.1. Learning-By-Doing.

5.2.1.1. Perspectives of the engineering dean.

It was important to explore and understand the perspective of the engineering dean on LBD, as his position makes it imperative for him to be in charge of the implementation process. Also, the dean is expected to be the leader for the LBD initiative and hence is required to have an in-depth understanding of the concept. He is regarded as the source of credible and relevant information for practical application by the instructors. His understanding of LBD is presented under thematic headings [No Exact Definition, Experiential Learning, Reflective Analysis and Self-criticism, and Personalized Education] derived from his own words as follows in this section.

No Exact Definition: The dean chose to use broad terms to frame his understanding of LBD while acknowledging the difficulty in narrowing it down to a specific definition. At the very beginning of the interview, he described LBD as a "fairly permissive term", which set the foundation for a non-restrictive interpretation of the concept. He also opined that LBD "hasn't got an exact definition".

The dean further stated that he sees LBD as "all-embracing", and advised against underestimating its permissive nature.

Experiential Learning: While emphasizing the view that LBD is not constrained by a precise definition, the dean highlighted experiential learning as one of its main identifying traits. The dean elaborated on this idea with the statement, "I would say that learning by doing is primarily focused on experiential learning and so I think that if there is one unique characteristic of it, it's the focus on experiential".

He further explained that his view on experiential learning would be subjected to a "fairly permissive" interpretation, echoing his earlier description of LBD. The dean summed up experiential learning as involving "the classic work placements, going out to the workplace or doing the labs". Based on the dean's response, it is evident that he considers work experience in a supervised, professional environment and empirical work in laboratory sessions, which fall under experiential learning, as an essential facet of LBD.

Interestingly, the dean also put forward the view that experiential learning can also include conventional learning. He noted that a case could be made for essay or report writing, and pointed out that certain forms of assessment that are generally considered traditional can be included in a wider understanding of experiential learning, and by extension, LBD. He explained his position in greater detail in the following statement:

> So it's not just on field work. I think that's the important thing. And it's not necessarily just the lab work. So for example, if you did a report writing exercise…or an essay on [an economic cost], then to close that loop [you] get an assessment, get it marked and then get the students to reflect on what they learned from that exercise. That is experiential learning…report writing is pretty important…and they'll probably use that report writing far more than they will do welding.

Reflective Analysis and Self-criticism: Building on his understanding of experiential learning in the context of LBD, the dean introduced the idea of reflective analysis and self-criticism. He mentioned the importance of understanding the pedagogy behind the philosophy and referred to the experiential learning style theory developed by

the educational theorist and psychologist David Kolb. He reiterated his view that the scope of experiential learning extends beyond hands-on experiences and lab work, and shared the following perspective: "[The Kolb model] is very much the hands-on experience of learning, but the critical bit is, then, a reflective analysis of that".

The dean underscored the relevance of reflective analysis, which allows a student to take a step back from doing a particular task and consciously reviewing what has been done or experienced. He also highlighted the value of self-criticism or "guided" criticism in the experiential learning exercise. Through self-criticism, students can critically evaluate and reflect on their views and learning.

Personalized Education: The dean transitioned from his discussion of reflective analysis to the topic of personalized education, which refers to instructional approaches that are geared towards meeting the specific learning needs of individual students. He indicated that reflective analysis opens the door for greater focus on the individual student in a more systematic way that falls within the ambit of LBD. According to the dean, "Learning-By-Doing can be personalized education, so you could maybe make it a personalized experience".

5.2.1.2. Analysis of the dean's understanding of LBD.

Based on the dean's response, it is clear that he does not have a precise interpretation of LBD. He acknowledged as much by saying that LBD does not have an exact definition. His use of the word "permissive" on several occasions during the interview reinforced his broad and open interpretation, which goes against any attempt to neatly and conveniently place the practice of LBD in a box and impose boundaries on its nature, scope, and meaning.

Despite the dean's "all-encompassing" perception of the LBD practice, he was able to identify experiential learning as a primary focus and the "unique characteristic" of LBD. This view is in line with the literature review in Chapter 2, which notes that experiential learning is at the core of LBD (Meyers & Nulty, 2009). The ideas that shaped the dean's understanding of LBD are summarized in Table 5.1.

Table 5.1

Key Terms Used to Explain the Dean's Understanding of LBD

Key Terms
LBD doesn't have an exact definition
Self-criticism or guided criticism
It involves the classic work placements, going out to workplace
Experiential learning can also include or encompassed conventional learning
Experiential learning
Reflective analysis
Personalized education based on personalized experience
It is difficult to assess because experiential learning is difficult to fathom

The dean expressed the belief that LBD involves conventional learning as well as "going out to places", implying that LBD entails a mix of classroom lecture-style teaching and experiential learning. He also mentioned self-criticism and reflective analysis as parts of LBD, which are mentioned in the literature as components of LBD. His knowledge of these concepts indicates he has a deep understanding of the LBD concept.

The dean also referred to "personalized education" to denote LBD, which may indicate his belief that LBD encourages every student to become familiar with the content on a personal level.

5.2.1.3. The perspectives of engineering instructors.

During the in-depth interviews, all eight instructors were invited to share their understanding of LBD, providing the data for research sub-question 1. The instructors, who are all full-time employees at HCT, each teach a particular discipline related to engineering for a minimum of 20 hours a week. They have varying levels of experience and qualifications, with six of them possessing doctoral degrees. The data collected during the interviews led to the emergence of several themes relevant to the research sub-question. The following section is presented using themes that emerged from the

interview transcripts. These are practical aspects of learning, critical/analytical thinking, and project-based learning.

Practical Aspects of Learning: Several of the participating instructors shared the view that LBD was primarily about the practical aspect of learning. While they used different words and phrases, and in some cases espoused wider perspectives, they expressed the same idea – that their understanding of LBD was framed by practical engagement with students and real-world context.

Instructor 4 described his understanding of LBD as "Making theory understandable by practical [approaches that] make students do the same things by themselves". He elaborated that the goal of LBD was to make the student understand the theory being taught in the classroom by doing practical exercises that can take the form of lab work. Instructor 2 mentioned that her understanding of LBD involved "experiencing knowledge" and "utilizing the concepts learned [in a] real-life situation", but noted that her view extended beyond this idea in isolation. She pointed out that "careful design of practices by the instructor…allows students [to] get a foundation for knowledge". It is observed that this instructor links the success of LBD to the designing of practices by the instructors.

Instructor 5 summed up his understanding of LBD by stating that it provides support to students, especially those who cannot quickly grasp the concepts being taught in the classroom, by applying those concepts practically in the laboratory. Instructor 3 expressed a similar view in describing LBD as "conceptualizing or materializing what the student learned in the class. There are some theories and concepts, and they see the real world use of those concepts". This instructor implied that LBD is successful when students can see the real-world application of theories.

Instructor 8 distilled the essence of her understanding of LBD in the following statement: "I believe that we get to learn things only when we do things and put them in practice. We see the practicality aspect of learning from [the] theoretical thing is how I define LBD". This instructor added that in a field such as engineering, "any learning is incomplete without doing it".

In sharing the philosophical and historical basis of his understanding of LBD, Instructor 7 noted that people started learning things by doing them from the beginning of civilization. Describing it as an "old concept", he explained that the absence of accumulated knowledge at the earliest stage of human existence meant that learning by doing was the only option. Having laid this foundation, Instructor 7 concluded that his understanding of LBD is when a learner confirms a theory that is being taught to him or her by actually "doing it", which involves carrying out some activity to prove the theory. He noted that allowing students to perform experiments in the classroom or laboratory would benefit their learning as they become more comfortable with the practice of justifying or validating what is taught to them.

Critical/Analytical Thinking: Instructor 1 emphasized that LBD has "different meanings from different types of programs". He pointed out that, for example, the meaning for engineering would not be the same for someone doing a diploma program, technicians, or MBA candidates. This understanding of LBD recognizes that it may be manifested in different ways depending upon different courses or learning environments. In the context of engineering studies, Instructor 1 noted that LBD is "working on analytical thinking, thinking and formulating a problem, and understanding the practical application of concepts". He explained that while hands-on practices are a component of LBD, his understanding gives primacy to analytical thinking and problem-solving.

The perception of Instructor 2 is closely aligned with the ideas expressed by Instructor 1. Instructor 2 outlined her understanding of LBD in the following statement:

> LBD is a process of learning, exploring, discovering, and experiencing knowledge. LBD to me is not only utilizing the concepts learned into the real-life situation. It involves the careful design of practices by the teacher that allows students to have a good foundation for knowledge and understanding and then it provides also opportunity to explore and develop new ideas and then create a meaningful and relevant learning experience that will then be [used] outside the learning environment.

While Instructor 2 gave considerable importance to the application of concepts to real-life scenarios, she noted that there is more to LBD than this single component. She expanded on the notion of "careful design of practices" by referencing exploration practices that she uses in her classroom. She further explained:

> I posed question or problems and asked students to explore possible conjectures that require validation. This activity aims to foster [the] ability of the students to generalize and develop deductive thinking. That's the first. To me, that's the highest.

Instructor 2 also indicated that she frequently asks students to make decisions about the mathematical model that is appropriate in solving problems. This is mainly the application of the mathematical concepts to learning.

Project-based Learning: Instructor 6 defined LBD as project-based learning and made significant effort to point out that this is much more than routine lab work. He stated: "Instead of having this type of traditional experiment in the lab, a project-based [approach allows] the students [to do] certain projects so they can understand the main concept of the subject". He expressed the view that project-based learning potentially places a much greater focus on real-world issues, and students find it much more interesting and enjoyable. He added that this project-based approach is sometimes accompanied by a problem-based approach that requires students to find resources and understand the concept to solve problems.

Instructor 4 mentioned "project-related work based on the theory and practical" in his understanding of LBD. Instructor 8 also highlighted the importance of projects as well as case studies that allow students to choose and apply all the relevant theoretical concepts. Using the topic of Health Safety & Environment (HSE) as an example, he elaborated on his point with the following statement:

> I asked [the students] to do a project on the safety aspect [and they selected and applied] all the theoretical concepts… HSE is a very theoretical and 'dry' subject. If I don't take advantage of this [project-based approach], it becomes very boring for them just learning the pages…So this [allows] them

to understand the subject, and to know the practical aspect, they can face the exam or whatever it is in a better way.

5.2.1.4. Analysis of instructors' understanding of LBD.

The fact that most of the respondents explained their understanding of LBD by enumerating the impact alone, possibly indicates a partial understanding of LBD when compared to more holistic consideration of all LBD practices found in the Chapter 2 literature review. It could also be inferred that because of their different understandings of LBD, the respondents' applications inside the classroom may also differ in terms of their approach. For example, while some instructors may want to use project work alone, others may focus more on showcasing real-world examples of theoretical applications to students.

Table 5.2 shows the main points emerging from each instructor's perspective on LBD. It provides a useful snapshot of the individual instructor's understanding.

Table 5.2

Instructors' Understanding of Learning-By-Doing

Instructor 1	-	it is analytical thinking, thinking and formulating a problem, and understanding the practical application of concepts
	-	it has different meanings from different types of programs
Instructor 2	-	a process of learning, exploring, discovering and experiencing knowledge
	-	utilizing the concepts learned in a real-life situation
	-	careful design of activities by the instructor to allow students to get a foundation for knowledge
	-	an opportunity to explore and develop new ideas
	-	the creation of meaningful and relevant learning experiences to use outside the learning environment
Instructor 3	-	conceptualizing or materializing what the student learned in the class
	-	it is a hands-on, practical application to reinforce a concept
Instructor 4	-	is to make the student understand the theoretical concept by some practical work
	-	it involves lab work
Instructor 5	-	is a process of learning, exploring, discovering and experiencing knowledge
	-	utilizing the concepts learned in real life situations
Instructor 6	-	is project-based learning
	-	a problem-based approach that requires students to find resources and understand the concept to solve problems
Instructor 7	-	LBD as a very old concept
	-	student confirms a theory that is being taught to him or her by actually "doing it"
Instructor 8	-	allows students to see the real world of the concepts or theoretical constructs that they learned in class
	-	any learning is incomplete without actually doing it in a field like engineering

During the interviews, almost all respondents suggested the need for a clearer and more concise definition of LBD produced by the institution. Specifically, as Instructor 1 stated, "We need a more expansive definition of Learning-By-Doing that captures what distinguishes, as well as what unites all members of engineering divisions in a shared educational initiative".

The key terms used by the instructors to denote their understanding and definition of LBD are listed in Table 5.3.

Table 5.3

Key Terms Used by the Instructors to Explain LBD

Key Terms	
Different meanings in different contexts	The practical aspect of learning/Laboratory work
Experiential Learning	The practical aspect of learning/Laboratory work
Includes critical thinking	Integral part of engineering
Old concept	Life-long learning
Life-long learning	Apply learning to real life
Project-based learning	Applying theoretical knowledge

It is notable that most of the instructors appear to view LBD as the application part of teaching with "theoretical" knowledge being the initial teaching part. Almost all respondents appear to have highlighted the importance of the union of theory and practice, with an emphasis on the latter. How best to achieve such a union and what the results might be, appeared to be the point of divergence among the respondents. It may be concluded that most of the respondents believed LBD is not a "stand-alone" philosophy or practice, but instead, it is intrinsically tied in with making the theory more relevant and understandable.

Another observation gleaned from Table 5.3 is that many respondents also subscribe to the notion that LBD should be related to real life practices. From their perspective, 'real life' means the practical use of knowledge. As explained by Instructor 6, "In all my courses, I use a project component to assess my students, the traditional experiment only covers the concept, but the project-based element is how to apply it into

a real-life scenario". The connection of real-life learning to LBD has also been extensively explored in the literature.

5.2.1.5. Comparison of dean and instructors' understandings of LBD.

The experiential learning understanding was mentioned by the dean and six out of the eight instructors. This is in agreement with widely published literature about the roots of LBD. Experiential learning, and its cooperative learning and collaborative learning subsets, exemplify the philosophy of LBD. However, as verified in the interviews and follow-up questions, most of the respondents understood experiential learning as a type of "hands-on" learning that does not emphasize the promotion of discussion, critical thinking, reflection, introspection, and retrospection. As Instructor 8 stated, "LBD, as the name suggests, is something I believe where we get to learn things and put them in practice so we can see the practicality and benefits of what was being learned". In this aspect, the experiential learning described by most of the respondents has something to do with involving the student in the learning experience so that he or she can understand the concept. Thus, this is akin to active learning, rather than being true to the construct of experiential learning involving critical thinking and introspection.

Using the information from Table 5.1 and Table 5.3, it is possible to compare and contrast the understanding of the dean and the instructors more clearly. Table 5.4 shows the common themes that emerge from this comparison.

Table 5.4

Similarities in Dean's and Instructors' Understandings of LBD

Dean	Instructors
Experiential Learning	Experiential Learning
LBD has no definite definition	LBD has a different meaning in different contexts
Doing the labs	Practical aspects of Leaning or lab work
It involves the classic work placements, going out to the workplace	Relating to real world/ Project based learning/ Apply learning to real life
Reflective Analysis and / self-criticism or guided criticism	Includes critical thinking

The following table highlights the differing viewpoints on LBD as espoused by the dean and the engineering instructors.

Table 5.5

Differences in Dean's and Instructors' Understanding of LBD

Dean	Instructors
Expansive concept	Old concept
Personalized education and personalized experience	An integral part of Engineering
Experiential learning that can encompass conventional learning	Problem-Solving
Difficult to assess	Life-Long learning
	Supports theory
	Involves application of theoretical knowledge

Table 5.4 and Table 5.5 show that the dean's views on LBD centered on its essence at a conceptual level and he understood LBD as an idea or a construct, rather than a practical set of activities. On the other hand, the instructors talked in more concrete terms (problem-solving, supporting theory, application) and observed LBD as an amalgamation of activities or tasks. It is posited that the dean's and the instructors' understanding are valid, as LBD is both a construct as well as a concrete set of practices (Roberts, 2012). However, to deliver LBD successfully in the classroom setting, it is supposed that the instructors should have the abstract and conceptual level of understanding LBD, as well as responsibility for the activities and practices they deploy to enact LBD in their teaching.

5.2.1.6. Instructor perspectives on the successful implementation of LBD.

Research sub-question 2, "From the perspective of instructors and students, which LBD practices have successfully been implemented in the engineering department?" is addressed by drawing on two distinct data sets. This section presents the qualitative data relating to instructor responses. Quantitative data relating to student responses have been presented in Chapter 4.

Asked to identify the LBD practices they had used with their students, instructors mentioned a diverse set of practices they were using or had successfully used to implement LBD. Table 5.6 summarizes key findings from the interviews with the instructors.

Table 5.6

LBD Practices Followed by Instructors

LBD Practices	
Laboratory activities/experimentation (All)	Peer demonstration (Instructor 2, 3 and 4)
Project-based (Instructor 6)	Exploration (Instructor 2)
Design process (Instructor 2)	Modeling and non-routine problems (Instructor 2)
Industry visit (Instructor 3)	Problem-based (Instructor 1 and 8)
Doing the Problem on the board (Instructor 1)	How to Apply to real-world problems (Instructor 6)
More than experience or lab work (Instructors 5 and 8)	Experiential learning via industrial field trips, keeping systematic work diaries of learning (Instructor 8)
Demonstration (Instructor 3 and 4)	

Regarding the practices followed in LBD, it was claimed by Instructor 2 that

> …exploration, modeling, and non-routine problems are some of the chief practices where questions or problems are posed to students to allow them to explore possible conjectures that require validation, thereby fostering the ability of the students to generalize and develop deductive thinking through exploration.

Regarding modeling, it was stated the students were asked to make decisions about the mathematical model that is appropriate in solving routine and non-routine problems.

Instructor 3 claimed that:

> Learning by doing works very well by doing simple things like visiting some companies … or we show the students how a plant works or a single

process works …. We put them in teams and ask them to work with each other to design and process.

Another practice is having students formulate a relatively straight forward problem and then asking them to come up to the board and solve the problem themselves. This activity was expected to help in identifying students who displayed difficulty in problem-solving. In the words of Instructor 1, "during my first semester, I realized the students have difficulty in formulating a problem. So the activity I do in the class is actually like I ask them to come up on the board and do the problem themselves".

Most of the respondents mentioned implementing the practices of LBD by conducting practical projects and implementing experiments in the classrooms to engage the students in hands-on experiences. In relation to hands-on courses, the instructors mentioned they assessed the students and trained them in LBD through practical experiments and laboratories. As an example, Instructor 4 asserted that "30% of the courses in the program of Engineering have some labs…. labs are part of doing experiments and labs are part of the curriculum".

For Instructor 6, practices involved more than just a traditional experiment to cover the concept, but the project-based is how to apply it in the real life scenario. With engineering as a skills-based field, it is no wonder demonstrations, and laboratory practices received the highest attention. In this sense, it is already compatible with the "active" part of LBD.

Instructor 5 and Instructor 8, however, mentioned experiential learning is not just experiencing, and it is not just lab work. Instructor 8 highlighted that "by focusing on teaching and learning, understanding the pedagogy, engaging in industrial field trips, keeping systematic work diaries of learning are some types of experiential learning that are practiced in my courses".

The data show that the instructors believed that they were successfully conducting LBD practices in the form of field trips, problem-based learning, demonstrations, and projects (Table 5.6). However, several other essential aspects of LBD practices such as quality reflection, learning that occurs in the context of a goal,

and learning that is planned do not appear to be implemented or practiced by the instructors.

These findings highlight the fact that the Instructors were enabling the students to engage in practices – possibly because they understood LBD as a verb – doing. The other essential parts of LBD, like spending time in reflecting on the content presented or creating linkages between the present and past learning or critical thinking regarding problems and solutions were not reported. Neither was there any mention of contextualizing learning within specific goals, which can be linked to real life and job relevant utility for the students. There was also no mention of any deliberate planning by the instructors for bringing about LBD into their classes. Rather, the responses indicate that most LBD was enacted on an ad hoc basis, wherever the instructors perceived a scope of involving students 'doing' – coming to the board and solving the problem; visiting off-sites; doing lab work – they were encouraging students to participate. They did not appear to be teaching students LBD as a way or an approach to learning where students learn to engage with the content in a critical way, indulge in reflection, think laterally, relate learning to past or future scenarios and get a comprehensive understanding of not only the content, but the process of engaging and understanding the content.

5.2.2. Exploring 21st Century Skills in the context of LBD.

This section discusses the responses to the research sub-question 3, which asks what 21st-Century Skills are taught, learned, and assessed in the practice of LBD from the perspective of the dean, instructors, and students. The perspectives of the students are not addressed in this section, as these data fall under the purview of the quantitative research findings presented in Chapter 4.

As outlined in the Chapter 2 Literature Review, a comparison of prevailing 21st Century Skills frameworks concluded that creativity, communication, collaboration, teamwork, critical thinking, cultural sensitivity, ethical behavior, life skills problem-solving innovation and technological literacy are essential 21st Century Skills. In the

semi-structured interviews, the instructors and the dean were asked to reflect on how these skills were adopted and assessed in their classroom practices. A complete list of interview questions can be found in Appendix A. The interviews were aimed at understanding instructors' and the dean's perceptions of LBD practices and 21st Century Skills and how they were being implemented and assessed in classrooms.

5.2.2.1. The dean's understanding of 21st Century Skills.

While research sub-question 2 was aimed at exploring which skills were being taught and assessed in class, the interviewees were allowed to give detailed answers and present their opinions. As such, the dean of the college provided insights into the significance of 21st Century Skills. The dean's opinions on how the skills are to be implemented and assessed are crucial since much of the curriculum development, as well as instructors' direction, is derived from the dean's office.

The engineering dean highlighted the significance of embedding 21st Century Skills in the way engineering courses are delivered and assessed, saying that "the UAE engineering students need to possess those skills to survive in the current corporate world". He used the term 'professional skills' for 21st Century education to highlight the listed skills. The dean referred to the ongoing global survey of engineering students being conducted by the US-based National Academy of Engineering (NAE) (2010), which had revealed that to meet today's challenges, engineering students must have the capacity to apply knowledge in practice by learning to adapt to new situations, by having critical and self-critical abilities, and by incorporating teamwork and communication skills.

The dean went on to highlight the opportunities and challenges of engineering education in the 21st Century, contending that the new professional engineer not only needs to be knowledgeable in his or her discipline but also needs a new set of professional skills and competencies. More importantly, the dean mentioned engineering educators need to integrate diverse classroom techniques adding that almost 50% of engineering courses are already applying those skills in the way the courses are delivered. The dean added that "[i]t is the responsibility of instructors to identify the skills they want to

promote in each lesson". These responses, however, underscore the fact that the dean is not in favor of instructors being formally provided with a prescribed format for imparting and assessing critical 21st Century Skills in the classroom. Instead, the dean believes that the onus of understanding and determining which skills should be taught or assessed should be left to the discretion of the instructors. This is an important finding, as when reading along with the findings from the instructors' responses, it emerges that the instructors were struggling with this onus of subjective implementation and assessment and did not firmly grasp the concept of 21st Century Skills.

> On the question of how to assess the 21st Century Skills, the dean explained: …you could assess several ways. For example, we do a lot of teamwork in assessments. And you could either do that in a systematic way in terms of looking at those core features of teamwork in terms of flexibility, in terms of leadership, in terms of team support, in terms of initiating ideas, in terms of whatever you want to identify and you could evaluate that with regard to a person's role and get feedback. I think feedback is an important thing. Do we do that? No, we don't.

The above answer gave several insights. For one, the dean had an understanding that the assessment needed to be done by breaking down behavior outcomes in several 'core features' and, two, that feedback was important for assessment. He is also aware that feedback was not used and this may probably be an area of improvement. In summary, Table 5.7 summarizes the dean's view on 21st Century Skills taught and assessed.

Table 5.7

Summary of Dean's Responses to 21st Century Skills

Respondents	21st Century Skills Understanding	21st Century Skills Taught	21st Century Skills Assessed
Dean	The respondent has a clear understanding of 21st Century Skills. He defined some of the skills to include their elements in assessments of students.	Half of the engineering courses use the 21st Century Skills. Those skills should have been covered in every course/module.	Not really, but should be included with a clear rubric during lesson and assessment.

5.2.2.2. Instructors' views on 21st Century Skills that are taught and assessed in the practice of LBD.

This section presents the findings from the instructors' interviews. The instructors' responses are grouped into three categories: understanding of 21st Century Skills; implementation of the 21st Century Skills; and, assessment of the 21st Century Skills.

5.2.2.3. Instructors' understanding of the 21st Century Skills.

Based on responses, it is obvious that not all respondents fully understood the concept of 21st Century Skills as outlined. For example, Instructor 1 asked questions like: "What is this? Life skills?" He also appeared to be confused between creativity and innovation skills. Instructor 4 appeared confused about the definition of communication skills (See Table 5.8 for full details). While the respondents understood the general meaning of the terms, they were at a loss when they were asked about the same terms in the context of their inclusion in classroom activities and assessments. A similar theme of inability to define any specific skills was observed in almost all the respondents.

5.2.2.4. Instructors' implementation of the 21st Century Skills.

Instructor 2 mentioned the following skills as being taught in the classroom: "One is collaboration - students like learning from their peers, as well as teamwork, critical thinking, life-skills, and problem-solving". Instructor 3 stated, "Critical thinking, the first

thing… Innovation and creativity …teamwork and problem solving". Instructor 5 confirmed that students get chance to implement and practice all the skills.

5.2.2.5. Instructors' assessment of the 21st Century Skills.

When asked about these skills being formally assessed, most of the instructors stated that this was not the case. Instructor 1, for example, noted that these skills were assessed informally through direct observation or individual contribution to a group effort. According to Instructor 1, teamwork can be assessed when the students work together on a project or lab activity. Instructor 2 stated that while she assessed problem-solving and critical thinking, other skills such as collaboration, learning from their peers, teamwork and life-skills were also being taught in the classroom.

When Instructor 6 was asked about the assessment of 21st Century Skills, he mentioned that he "assesses indirectly without a rubric". This is not surprising since most of the assessments of engineering subjects are technical, which means they usually use a quantitative approach. Skills like collaboration, creativity, innovation, ethical behavior, and cultural sensitivity would seem to require a qualitative evaluation framework to be assessed. Seven out of the eight respondents admitted they do not include the majority of these skills as part of their assessments.

5.2.2.6. Reasons for lack of assessment.

When asked a follow-up question on the reason why the majority of 21st Century Skills were not included as part of their assessment, most instructors simply said that it was not required in the course outline, some ventured on to say it was difficult to assess these skills as they seem to be fraught with subjectivity, which to them is a departure from the objective and the type of assessment engineering students are used to having.

For example, Instructor 7 mentioned the following while talking about assessing the skill of problem-solving:

> Ideally speaking yes, we should give but practically speaking it is not easy from the students' point of view because we have to be sensitive to the students also.

> Both of them have done it correctly we are giving much to the innovative one, it's okay we should give, but I prefer not to do that.

Instructor 2 stated that "collaboration, of course, you cannot assess it in Mathematics". And, "I cannot find a way to assess life skills in mathematics". According to Instructor 6, the assessment was done subjectively: "No. There is no rubric or something. It is just based on my, you know, subjective [judgement]". This instructor also mentioned that for assessing critical thinking, "I have a background of things and then the level of students I expect them to resolve some issue that usually comes up when making the project. … How they see the problem. How they connect the components of the problem".

However, not all 21st Century Skills were unfamiliar to the respondents. Some of the instructors stated that technological literacy, problem-solving, teamwork, ethical behavior, and collaboration were mostly included in their assessment tools. This finding may be corroborated by the fact that most of the engineering exams are experiments, which require solving mathematical equations and using computer tools. According to the instructors, communication is also assessed in presentations and the question and answer portion of the projects. As an example, Instructor 5 mentioned communications as being informally assessed:

> Somehow it is. It is being assessed, or it is being implemented in the LBD activities. Because in some project or some homework we asked students to explain so at least they know how to first correct spelling, say it, and express their thoughts in words.

All respondents except one mentioned that critical thinking, creativity, and innovation skills were not formally assessed during the activities in the class. Instructor 4 reflected that "It is not easy to assess creativity, how are you going to do it and the same problem [exists] with innovation and critical thinking".

All of the respondents agreed that the 21st Century Skills should be taught and learned, but they also stipulated clear guidelines on how to assess these same skills were

required. According to the respondents, in the event of a lack of clear guidelines, it is left to the "discretion" of the instructors, and in this situation, the assessment might be construed as biased. For instance, Instructor 6 stated that in some of the problem-solving items, there might be more than one way to solve a particular problem:

> For example, there may be a student who had provided an elegant solution and another, who had used only a standard solution. Both final output answers are correct, so, is it required for the instructor to give extra points to the first student? If so, how will this be added to the total score of the exam which is usually fixed from the start? Will we now 'force' all students to find 'elegant' solutions to problems?

The instructors perceived that these questions needed to be clarified in an assessment policy framework, which currently HCT does not have.

As in the case of LBD implementation, the respondents appeared to be looking for guidance and direction when it comes to incorporating the 21st Century Skills in their classroom experiences. The difference, however, is that while most of the respondents appeared confident in implementing LBD, as all of them believed they had done so at some point of time, most of them agreed they have no experience in including 21st Century Skills as part of their assessment strategy.

An emerging theme can be identified from this discussion. The instructors were finding difficulty with assessment because there was hardly any structured format or framework available for them to make such an assessment; also, in certain cases, instructors were completely unaware of the exact nature of constructs defined by skills like 'life skills' or 'cultural skills'; and thirdly, in some cases the instructors did not seem to understand the value of the skill or did not connect it with what was being taught. In summary, the skills mentioned as taught in class by instructors is presented in Table 5.8.

Table 5.8

Summary of Instructors' Responses for 21st Century Skills

Respondents	21st Century Skills Understanding	21st Century Skills Taught	21st Century Skills Assessed
Instructor 1	The interviewee is unsure of the definition of these skills. He struggles to distinguish between some terms, such as creativity and innovation.	Innovation, creativity, team work, problem-solving, communication, ethical behavior	This instructor is unaware of how to assess his students on any 21st Century Skills. None of those skills is assessed. Except, team work is assessed through project or lab work done together.
Instructor 2	The respondent is unclear on the definition of 21st Century Skills.	Team Work, collaboration, critical thinking, problem-solving, life skills	Yes informally. Not with a set of the clear rubric.
Instructor 3	The respondent was aware of the 21st Century Skills and answered some questions about their definitions	Creativity, teamwork, critical thinking, problem-solving, and innovation.	Yes. In a rubric.
Instructor 4	"I don't understand what you mean by communication." Respondent seems to understand all the other skills.	Problem solving, critical thinking, teamwork, collaboration, and life-skills.	Not all are assessed. Problem-solving, critical thinking, teamwork, and collaboration are hard to assess. But others I do assess in LBD activities.
Instructor 5	Don't understand cultural sensitivity. Some confusion about the definitions of some skills.	All skills are used in LBD activities.	All skills are assessed except ethical behavior and critical thinking. No rubric is available.
Instructor 6	The respondent is clear about the definition of 21st Century Skills.	Creativity, communication, collaboration, teamwork.	All are assessed. Some might have an indirect assessment. No rubric presented.
Instructor 7	The respondent seems to understand 21st Century Skills.	Teamwork, collaboration; almost all of the 21st Century Skills.	All indirectly assessed. No rubric is available.
Instructor 8	The respondent was not aware of the distinction between innovation and creativity. Also, he could not understand the use of life skills in classrooms; difficultly with definitions.	Collaboration, teamwork, ICT, and life cultural sensitivity are used.	None of the skills are assessed directly.

5.2.3. Toward better implementation of LBD.

The overarching research question, '*What constructively aligned Learning-By-Doing (LBD) pedagogical model, incorporating 21st Century Skills, can be developed for enhancing the teaching of engineering at HCT, UAE*?' required developing insight into factors that may be preventing the deployment of LBD practices and 21st Century Skills. Also, it was deemed essential to understanding what factors may be needed for the successful implementation of LBD as a pedagogical model.

5.2.3.1. Challenges faced in the successful implementation of LBD.

In addition to exploring how the instructors perceived their success in implementing some of the LBD practices, it was deemed appropriate to ask them about any challenges that they faced during the process.

It was also important to find out how the instructors implemented LBD practices in their classrooms, given that this was their responsibility. Thus, it was important to explore the instructors' concerns and challenges they perceived in applying LBD in their daily instructional practice. The respondents were, therefore, asked, 'What issues/problems arise or may arise in implementing LBD practices?' The aim was to emphasize that no issue or concern, however, small should be overlooked.

The issues and concerns expressed by the instructors were classified into four main areas: Curriculum, Instructor, Student, and Management. At the forefront of these concerns, according to the respondents, was the lack of clear guidelines from the college management on how LBD should be implemented. "LBD was imposed on us without any prior knowledge of what is LBD and how to use this new concept. To be honest, I never heard of the concept before I joined the college" (Instructor 7).

Instructors reported they faced issues such as identifying which course should contain more LBD elements. Concern was also expressed about the impact of the LBD practice on the learning objectives and the time needed to update the course outline. Instructor 1 revealed that for courses that are oriented to be more theoretical, where

analytical thinking is more detailed, LBD should be considered as more of a support and cannot be directly part of the assessment. Further, issues identified by Instructor 1 suggest HCT does not have enough modeling and simulation software. “Modeling and simulation is one area that can be advantageous when applying LBD practices for theoretical courses” (Instructor 1). Some of the instructors viewed the initiative as an extra burden on top of their usual practices, as “limited time is available to cover theoretical concepts and LBD practices” (Instructor 8).

While most of the respondents explained how they were applying and practicing LBD in their classrooms, they also mentioned the lack of guiding principles for its execution was a major concern for them, (Instructor 1, Instructor 6, Instructor 7 and Instructor 8). One particular area they highlighted was assessment. Instructor 1 stated they faced questions like:

> What percentage of the assessment strategy should be allotted to LBD practices? What tools should we use to assess these practices? Should we produce qualitative or quantitative assessment tools? How much time should be devoted to these LBD practices?

The respondents also expressed concern about the impact of the LBD practices on the students. Questions raised included: “Are the students going to wholeheartedly accept these changes?” (Instructor 8); and “Will it be effective for all types of students?” (Engineering Dean). A case in point was of the working students who might prefer a more traditional approach to learning as, “The commitment from the students who were also working is not there when it comes to conducting any type of hands-on practices” (Instructor 8).

Almost all instructors believed the LBD approach would require more time to implement compared to the usual approach. Others feared that the acceptance of LBD practices might jeopardize their student-instructor evaluation (Instructor 5 and Instructor 7). Some even ventured to query the wisdom on veering away from a “time-tested” paradigm of traditional teaching approaches. Five out of the eight instructors also

questioned their preparedness for this new approach (or LBD), acknowledging the need for workshops on how to effectively implement the initiative.

The final issue discussed was the impact of the LBD initiative on the current accreditation of the college with international bodies, particularly, the Accreditation Board for Engineering and Technology (ABET). Instructor 6 was concerned that reconstructing the curriculum might not be possible due to the constraints set by the accrediting bodies which require a specific format to be followed. These concerns need to be addressed and resolved if the LBD initiative is to be successfully implemented at HCT.

It is clear from the instructors' responses that their main issue was the lack of structure in implementing the LBD initiative. It can be concluded the underlying message the instructors were trying to convey was that they were in urgent need of professional development of what was required. The instructors wanted the management to prepare them for this endeavor by providing clear directives and frameworks. Also, it was evident that the instructors needed a change in mindset regarding the utility of LBD (see Table 5.3) to wholly embrace LBD and implement it in their teaching. Table 5.9 lists the challenges mentioned by the instructors and the dean in the successful implementation of LBD.

Table 5.9

Challenges Faced in Successful Implementation of LBD

Management	Curriculum	Student	Instructor
- Lack of Clarity and absence of Guidelines (Instructor 7) - Lack of modeling and simulation software that can be useful for LBD in theoretical courses (Instructor 1)	- Problem identifying which course should contain more "LBD" elements (Instructor 1) - Confusion on how LBD fits in with the learning objectives (Instructor 1) - Lack of guiding principles for LBD execution (Instructor1, Instructor6, Instructor7 & Instructor8). - Lack of guidance on: What percentage of the assessment strategy should be allotted to LBD activities? What tools should we use to assess these activities? Should they produce qualitative or quantitative assessment tools? How much time should be devoted to these LBD activities?"	- Lack of acceptance by students (Instructor 8) -May not be effective for all students (dean) -Working students do not want to indulge in extra hands-on activities (Instructor 8)	-No Prior Knowledge of LBD (Instructor 7) and need for workshops (5 out of 8 instructors) - LBD additional burden and causes time constraints (Instructor 8) - Time-consuming (All instructors) - May jeopardize their student-instructor evaluation (Instructor5, Instructor7) - Belief in "time-tested" paradigm of traditional teaching approaches - The perception that LBD may interfere with college accreditation (Instructor 8)

5.2.3.2. Suggestions for sustaining the Learning-By-Doing implementation in HCT.

The researcher took the opportunity to ask the respondents if, in their opinion, the LBD initiative was sustainable. The instructors were asked what they believed needed to be done to sustain the LBD implementation in HCT. The data gathered in response to this question has substantial implications for designing the LBD model itself. Similar to the concerns and challenges expressed by the respondents, the

responses to the question of LBD sustainability is be classified under four different areas: Curriculum/Course outlines, Students, Instructors, and Management commitment.

In the area of curriculum and course outlines, the instructors expressed a need for identification of the courses to be included in the LBD initiative, and also an understanding developed about the degree of involvement, arguing that not all subjects are "LBD" ready. Instructor 1 clearly stated that "for the courses which are more theoretical where analytical thinking is more detailed for them, LBD should be considered as more of a supporting act – it cannot be directly part of the assessment".

Another significant reply regarding sustaining LBD practices at HCT focused on "supporting, educating and professional development of the respondent to better persuade them to embrace LBD in a positive, non-threatening approach to their career" (Instructor 6).

The next requirement was highlighted by several instructors suggesting guidelines on 'how to map the curriculum components' should be provided. They proposed that mappings should include: Program Learning to Course Learning objectives, Course Learning objectives to LBD goals and objectives, and lastly, LBD goals and objectives to assessment methods. According to the instructors, the assessment strategy of the course also needed to be changed to reflect the weighting awarded to LBD activity types and assessments. It was further suggested that clear guiding principles on how to construct the teaching materials should also be incorporated.

Understanding that LBD is a more student-centred type of learning, the respondents also highlighted the need to motivate the students. Instructor 5, Instructor 7, and Instructor 8 stressed the need to motivate the students through assessment. According to Instructor 4, "They should feel that what they are working for will be rewarded in terms of grades". Some respondents believed that students need to be prepared psychologically for the LBD approach. Concern was also expressed about the impact of the LBD assessment tools on the students.

The instructors recognized for LBD to be successful, they needed to change as well. They voiced their willingness to undergo training, particularly in the construction of assessment tools that can effectively evaluate LBD practices.

For the most part, respondents did not appear to be hostile to the LBD initiative, but they were also not overly enthusiastic about its implementation. The respondents highlighted the "unpreparedness" of the current structure in adapting to the LBD initiative. As educators, all of them appeared to accept the challenge of the LBD directive, but they also understand they cannot do it alone. According to them, the initiative should be undertaken with some prior groundwork involving the unflagging support of management, the commitment of the educators, the presence of a robust structure to support it, and well explained to students. In summary, Table 5.10 captures the view of instructors on the challenges they faced.

Table 5.10

Challenges identified by Instructors in the Implementation of LBD

Area	Instructors' Comments
Curriculum/ Course outline	- Increase the weight of LBD in the course assessment strategies. - Provide specifications on what type of activities (documentation, structure, connection to learning outcomes). - Map the theoretical aspect of the LBD aspect. - Provide enough time for instructors to prepare quality, LBD activities. - Consider re-designing the learning; the assessment strategy and the whole course outline so allotted time is provided for instructors to create high quality of LBD activities. - Clearly, define it in the assessment portion of the course. - Put good weight on it if you want it to be done. - Maybe a handbook listing projects for each 1st, 2nd, 3rd and 4th year. - Identifying which courses lead to LBD. - Modeling and simulation is one area which can be a very good LBD activity for the theoretical courses. - Identify courses which are LBD oriented and courses which are not. Maybe separate courses into two components.
Students	- Motivating/engaging the students. - Appreciating and recognizing their work. - Learning should continue outside the classroom.
Instructors	- A respondent from a research background. - More training, more technicians; more support at all levels. - Provide workshops for instructors.
Management commitment	- Commitment from leadership. - Build relationships with vendors to get equipment and items quickly.

5.3. Summary

This chapter has reported on the findings from the interviews of the instructors and the dean at the College of Engineering, HCT. Data gathered from the respondents, and dean's interviews have shown diverse views on the understanding, practices, and definition of LBD. Since most of the respondents explained their understanding of LBD by enumerating the impact, it indicates the "partial" understanding of LBD. On the definition of LBD, respondents viewed it as the application of "theoretical" knowledge. This understanding is supported by LBD research literature. As engineering is a skill-based field, it was not surprising for the respondents to award a high percentage for

laboratory practices and experiments as the most used LBD practices. The clear importance of the 21st Century Skills was highlighted by all respondents, including the engineering dean during the interviews. However, most of the instructors reported not generally using these skills in the context of their classroom practices and assessments. Creativity, critical thinking, and innovation skills were highlighted as the most difficult to assess in the engineering courses. The instructors reported that they were unaware of the 21st Century Skills framework, and nor did they use it in their classrooms.

CHAPTER 6: MERGING AND DISCUSSION OF RESULTS

6.1. Introduction

This chapter aims to merge and synthesize the findings obtained from the data collection. As detailed in Chapter 3, the research employed a mixed methodology design that produced two sets of data: qualitative (from the interviews of the instructors and the dean) and quantitative (from the surveys of the students). While the two methods for data collection differ, the actual aim of both approaches was to obtain information that could successfully answer research sub-questions one, two and three as outlined in Chapter 1, and recapitulated as follows:

Research Sub-Question # 1: What are the current understandings of LBD from the viewpoint of the dean of engineering and the instructors?

Research Sub-Question # 2: From the perspective of the dean, instructors, and students, which LBD practices have successfully been implemented in the engineering department?

Research Sub-Question # 3: From the perspective of the dean, instructors, and students, which 21st Century Skills are taught and assessed in the practice of LBD?

The purpose of these three sub-questions was to gather the information that would be relevant to answering the overarching research question:

> *What constructively aligned Learning-By-Doing (LBD) pedagogical model, incorporating 21st Century Skills, can be developed for enhancing the teaching of engineering at HCT, UAE?*

The perspectives of the instructors, students, and dean provided key insights into answering the research questions. Both the surveys and the semi-structured interviews were designed to complement each other while accomplishing the shared objective of gathering information on the level of understanding and assessment of the LBD practices carried out at the institute under study. These research instruments also elicited

data on perspectives of which 21st Century Skills were being taught and assessed. The process of how these data were collected, analyzed and synthesized, as outlined in in Figure 3.1.

The data collected through the student surveys were presented in Chapter 4. This included student perceptions regarding which LBD practices were being used in their classes, as well as identifying the different 21st Century Skills that they perceived were being taught and assessed. Chapter 5 presented the analysis of the findings from the interviews with the dean and the instructors and noted their perceptions about LBD practices being implemented in the classroom along with their implementation and assessment of 21st Century Skills. This chapter, which aims to analyze and merge the results emerging from the two data sets and interpret them to present a needs-based case for a new LBD Model, is structured in the following manner. Firstly, the chapter identifies and develops themes around the current implementation of the 16 Learning-By-Doing practices. Next, themes around 21st Century Skills implementation and assessment are identified and developed. The final section of the chapter focuses on the development of key principles that seek to capture the summary of the elements that the data have shown need to be incorporated into the new LBD Model as developed in chapter 7.

6.2. Themes Around the Implementation of LBD Practices

The aim of bringing the analysis of the two data sets together (Figure 6.1) was to discover how students, instructors, and the engineering dean perceived the implementation of the LBD practices.

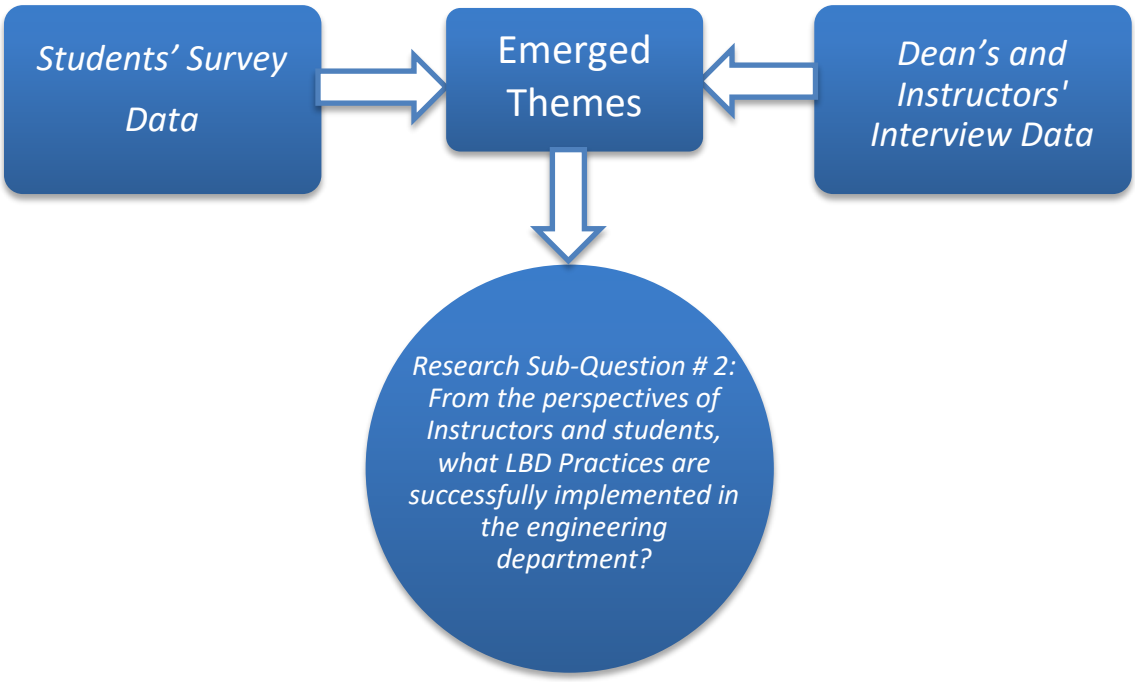


Figure 6.1. Themes around the current implementation of LBD Practices

It was anticipated that this merger of the two data sets might inform the development of a new LBD Model emerging from the research. This current discussion is an extension of the discussion in Chapter 5, where the perceptions of the instructors and the dean were merged to assess their understanding. The purpose of Chapter 6 is to use the findings from Chapter 4 (students' data) and Chapter 5, to establish a basis for the need for a new LBD Model intended to enhance the teaching of engineering subjects at the Institute.

Research Sub-Question #2 sought to ascertain the LBD practices that have been successfully implemented in the engineering department from the perspective of the dean, the instructors, and the students. To address this question, the instructors were asked about how they implemented LBD in their classes, and students were asked to note which LBD practices they believed were being undertaken successfully in the class. The instructors were asked to identify and elaborate on the LBD practices that they undertook, while the students were given a structured survey that listed LBD practices and sought to gain their perspectives on whether the LBD practices were being taught by

the instructors. As identified in the Literature Review, the *16* LBD practices include the following:

1. Developing Collaboration and Teamwork
2. Interactive Discussions
3. Post-evaluation of Learning
4. Formal Assessment of the Students Based on Real Scenario
5. Simulation and Models used by Instructors
6. Instructors First Demonstrating a Required Subject Skill
7. Drills and Practices
8. Students are Encouraged to Reflect
9. The Instructor Uses Real-Life Case Studies
10. Students are Presented with Problem-Based Questions
11. Instructors Conducting Practices that Allowed Students to Fully Experience the Topic
12. Classroom activities to model experiences or concepts are conducted
13. Activities that Cultivate Critical Thinking
14. Multiple Methods of Assessments
15. Activities that led to student motivation
16. Instructors encourage students to record their impressions

The following section will present the themes that emerged from the two sets of results. Table 6.1 is presented as a summary of the themes that emerged, identifying the findings from the data, the perceived effects and the implications to be taken into consideration in the formulation of the proposed new model.

Table 6.1

Themes from Merging of LBD Data

Themes	Findings	Perceived Effect	Implications To Consider for the New LBD Model
THEME 1 - Implementation of LBD Practices	Inconsistency in implementing LBD practices Lack of guidance and lack of structure in implementing LBD in a practical manner	Students not reaping the benefits of every LBD Activity	Need for an inclusive model, that proactively ensures ALL students are exposed to the range of LBD practices.
THEME 2 - Understanding of LBD Practices and Pedagogical Approach for LBD	Lack of clarity in understanding LBD Lack of guidance and lack of effective planning in implementing LBD Practices Lack of Structure for Implementing LBD in a practical manner	Ad hoc, unplanned, intermittent, and unstructured implementation (when happening) Subjective and skewed implementation of LBD	Need for a model backed by formal structure, and full understanding of what practices comprise LBD. Also, a formal model of delivery – so Instructors know which LBD practices to engage in and when this is appropriate. Need for a model that can give clear and open directions about LBD implementation
THEME 3 - Comparative Understanding of LBD Practices between the instructors, dean and the students	Lack of Clarity in understanding LBD on the part of instructors Students' lack of understanding of LBD Practices due to lack of explicit learning approach and methods Discrepancies between the dean and instructors over the understanding of LBD and implementation of LBD.	Instructors not sure what they are teaching and how Students are not sure what they are learning and how. Ground-level implementation discrepancies leading to ad hoc or subjective implementation of some of the practices Curriculum may not be sufficiently developed to include all the elements of LBD thus making it difficult for the dean and the Instructors to understand and implement Instructors may not be getting the support and guidance from the management	Need for a model that is not just theoretically rooted in LBD literature, but which specifically links students to the industry in which they will find themselves in the future. Need for a model that can give clear open directions about LBD practices and their implementation

These three themes will now be individually considered in more detail.

6.2.1. THEME 1 – Implementation of LBD practices.

A theme that came to light by merging the two data sets was that in a majority of cases, any given LBD practices was being perceived by roughly half the students, and identified by few if any, instructors. The combined findings, therefore, indicated that not all LBD practices were being implemented in the classroom, and not all students appeared to be benefiting from whatever implementation was happening. For instance, the student survey indicated only 72.3% of students believed that they were doing drills and practices and only 65.2% of the students mentioned that their instructors demonstrated the required skill or concept before teaching. These percentages were some of the highest scores for any LBD skill of the student survey, though it needs to be noted that even these were not 100%. This indicates that for any given LBD activity, not all of the students were aware of it being undertaken; and by corollary, not all LBD practices were being taught in class.

It is further noted that only four out of eight instructors mentioned using real-life case studies, and this was the highest mention for any LBD activity by the instructors. The findings indicate that not even one of the LBD practices was being implemented by all instructors, which means that the students did not benefit from every LBD practice. Additional findings strongly support the theme that not all practices were being implemented and not all students were benefiting from every practice. All findings from the students' survey indicate that not all students appeared to benefit from every LBD practices. For example, more than half the surveyed students mentioned LBD practices like 'Developing Collaboration and Teamwork', 'Students are Encouraged to Reflect', and 'Multiple Methods of Assessments' – supports the contention that LBD practices were not being taught. About 60% of students believed that their classrooms had 'Interactive Discussions'. A similar percentage believed that 'Simulation models' were used by instructors, that question and answers were posed in class to evaluate the learning that happened in class and that there was 'Post-evaluation of Learning'. Only about half the students believed that their exams evaluated their understanding of

problems and solutions in real life settings (Formal Assessment of the Students Based on Real Scenario), or that they were being taught using real life case studies (The Instructor Uses Real-Life Case Studies), or that their learning was based on a problem-solving approach (Students are Presented with Problem-Based Questions). About 50% believed that instructors were 'Conducting Practices that Allowed Students to Fully Experience the Topic', and that instructors were motivating them through 'Activities that led to Student Motivation'.

Although the majority of instructors believed that they were allowing students to engage in practices that enabled experiencing the lessons (instructors Conducting Practices that Allowed Students to Fully Experience the Topic), only 45% of students thought that this LBD practice was being implemented. A similar trend was seen in the case of the 'Institute Program Being Aligned with Industry Needs' where three instructors mentioned it, but 66% of students believed it was a reality. The merging of two data sets, therefore, underscores the identified theme that LBD implementation is not happening with every LBD practice - each LBD practice was not being implemented by every instructor.

There is inconsistency in the implementation of LBD, which can be traced to the underlying causes related to lack of guidance and lack of structure in implementing LBD in a practical manner available to the instructors. The perceived effect of this is that all students may not be benefiting from LBD and this underscores the need for a model that could ensure fuller implementation. These findings, therefore, point to the need for developing a model that can provide an explicit framework to enable the instructors to implement LBD practices in a purposeful and clear manner.
While it was manifest that LBD was not being undertaken completely, it was also found that understanding of LBD was limited. This understanding of LBD practices emerged as the next theme and is explored in the following section.

6.2.2. THEME 2 – Understanding of LBD practices.

Another theme that came into sharp focus when the two data sets were merged was the unplanned and seemingly unintentional way that several LBD practices were being

taught in class. While the data collected from the instructors did not explicitly mention some of the LBD practices that they encouraged in their classrooms, the data gathered from the students clearly showed that the students believed most of the LBD practices were included in their learning. For example, many theorists (such as, McLoughlin & Lee, 2008; Paulson & Faust, 2010; Redecker & Punie, 2013; Wagner, 2010) argue that 'Developing Collaboration and Teamwork' is an essential aspect of 21st Century education and LBD practices. This practice was identified by the students, but not mentioned by instructors. While 60% of the students had also noted that the LBD practice of 'Interactive Discussions' occurred during classes, this was not mentioned by either the instructors or the dean during the interviews. The instructors did not indicate that they used any structured approach in carrying out this activity. The lack of mention of specific LBD practices might indicate the instructors' lack of understanding or knowledge related to LBD. Moreover, this appears to be a significant omission as evidence from the literature suggests that interactive classrooms facilitate better learning behavior and produce a better learning outcome (Ginsburg, 2009; Leadbeater, 2008). Paulson and Faust (2010) also agreed that student engagement in the classroom through a diverse set of practices is an important element of LBD.

In the same way, another practice, 'Post-evaluation of Learning' was mentioned by 57% of the students surveyed, but consistent with the trend observed in the research data, none of the instructors mentioned this as a classroom practice to enable LBD in their sessions. There is sufficient academic work by theoreticians and scholars (Biggs & Tang, 2007; Cropley & Sitnikova, 2005; Houghton, 2004) to support the idea that 'Post-evaluation of Learning' is a necessary part of LBD because it enables the instructors to assess their students' abilities or limitations immediately and take the necessary course of action to achieve positive learning outcomes. Lack of understanding of the LBD practice displayed by instructors appears to reinforce the theme that LBD is not fully understood by the instructors. Also, another LBD practice that relates to the 'Formal Assessment of the Students Based on Real Scenario' and which evaluates if the students were able to apply their theories or concepts (Kolb & Kolb, 2005; Meyers & Nulty, 2009; Robinson, 2006) was not mentioned by any instructors. This LBD practice, while

missing from the instructors' data, was nevertheless present in the students' data, with more than 54% of students saying that they perceived this practice being implemented.

The merging of other data revealed a similar trend - 60% of the students surveyed indicated the existence of practices related to 'Simulation and Models used by Instructors', and once again, there was no mention of this in the data collected from the instructors. Simulation has been directly linked to conceptual understanding by students, as it enables the students to engage their senses such as hearing, touching, tasting, and smelling rather than seeing in two-dimensional space, and hence ensures comprehensive learning and creates better memory linkages (UNESCO, 2013). In the same manner, an LBD pedagogical approach requires that 'instructors First Demonstrate a Required Subject Skill' or the concept to the students so that the students can grasp the skill or concept. Only one instructor mentioned this practice specifically, though 65.2% of the students believed that 'Instructors First Demonstrate a Required Subject Skill' (before they were asked to engage with it themselves). This is consistent with the finding that there is a limited understanding of LBD at the instructor level. Lewis and Williams (1994), Clark et al. (2010) and Adamson and Darling-Hammond (2008), all believe the use of 'Drills and Practices' within the classroom setting is expected to bring about the more hands-on experience with the course content for the students. Although not mentioned by the instructors as part of LBD, data collected from students revealed that 72% perceive that 'Drills and Practices' formed a part of LBD practices being carried out.

The active encouragement of students to reflect or 'Students are Encouraged to Reflect' on their learning, was perceived by only 54.9% of the students and mentioned by only one instructor. Reflection is considered as a means of obtaining insights about personal strengths and weaknesses and in highlighting areas of improvement (Ackerman & Perkins, 1989; Gardner, 1999; Leadbeater, 2008). Based on the merging of the research findings from the two sets, it is evident that the students perceived certain LBD practices taking place in the classroom while the same practices were in general not acknowledged by the instructors. This could be a case of the instructors, including aspects of LBD in their lessons without having a full understanding of how their actions

relate to the requirement of an LBD-enabled classroom. That is, although the instructors did not mention their awareness or knowledge of LBD practices, they may still be using some of the practices in class. The underlying reason for this could be that the curriculum and the overall model of LBD as used at this Institute is not understood in practical terms by the instructors and does not provide a concrete interpretation of how to use LBD in class. Anderson, Potočnik, and Zhou (2014) support the need for a link to prepare students academically and equip them with the skills needed to succeed in practical, real-world settings, but this can only be done if there is clarity of what the instructors expect to deliver as an LBD activity and how the implementation is to be made.

To summarize, the result of this lack of clarity is that instructors may be using LBD practices in an ad hoc, unplanned, intermittent, and unstructured manner leading to its subjective and skewed implementation. There is, therefore, a need to develop a teaching model that cohesively and comprehensively distills the essence and practice of LBD with explicit, structured and specific directions for the instructors. There is a need for a model backed by formal structure, and full understanding of what practices comprise LBD. Also, an explicit model of delivery is required so that the instructors know which LBD practices to engage in, how to implement, and when to implement.

As can be seen from the above discussion, a shared lack of understanding of LBD can be gleaned from the fact that instructors omitted to mention a practice even when students perceived it, and also by the fact that at times instructors were unable to explain the practice even when they mentioned it. These findings point toward a deeper theme, one that indicates a gap at the basic level of the educational program used at the Institute. A theme that emerges is the lack of explicit pedagogical approaches to guide the teaching process. This is further elaborated upon in the following section.

Some of the responses from the students' survey and the instructors' interviews did appear to be aligned, indicating that at least some of the practices were being taught in the class in a planned and calculated manner and where the students and the instructors exhibited a degree of shared understanding. For example, several instructors had

mentioned that they used case studies or 'The Instructor Uses Real-Life Case Studies' in their classes, while 51.1% of the students also reported perceiving this activity as being undertaken in their classes. Case studies drawn from real life can illustrate the real-world meaning of learned material and give a concrete chance for the learners to witness the unfolding of the learned concepts in practical situations (Healey & Jenkins, 2000; Kane, 2007; Wagner, 2008). Three of the instructors reported that case studies formed a part of the LBD practices that they undertook. Thus, almost half the instructors and half the students seemed to believe that case studies or real-life scenarios were part of their teaching and learning. These findings are in contrast to the general trend of a lack of alignment between students' perceptions and instructors' contentions seen in the findings of the previous theme. However, this still does not necessarily imply that the Institute's instructors are aware of the need to use real-life cases or scenarios to facilitate LBD, as almost all the instructors and the dean had omitted to explain this LBD practice or to link it with learning.

A similar result emerged when the students' and the instructors' perceptions were merged regarding the LBD practice related to problem-based teaching (or 'Students are Presented with Problem-Based Questions'). It is, however, a practice that was reportedly not being undertaken consciously by the instructors. Though two of the instructors mentioned 'Students are Presented with Problem-Based Questions' as a practice they encouraged their students to do, their understanding of problem-solving did not seem to coincide with what is known of this practice under LBD as described in the literature. For example, two of the instructors mentioned that when they detected that students did not understand something, they would ask them to come to the board and formulate the problem on their own and then solve it. In both these instances, the LBD practice of presenting the students with 'problem-based questions' is enacted only in a limited sense. The instructors are not encouraging the students to apply their theoretical knowledge in any innovative or new way to apply to real-life problems. In effect, what is happening is that the instructors may be successful in enabling the students to grasp the theoretical concept better but are unable to instill an ability in them to use the theory and apply it in real life problems. So, further consolidating Theme 2, it can be reiterated

that the instructors did not relate problem-based questions as essential to LBD learning; though they may be presenting students with such questions as indicated by 49% of the students believing that they were being presented with problem-based questions. Both the data sets, however, seem to suggest that problem-solving practices were being implemented to a limited extent, suggesting a need to make pedagogical and curriculum changes to encourage the instructors to proactively and consciously teach using LBD practices. The underlying reason for this lack of standardized and structured implementation of all LBD practices is probably the informal, unplanned, and unstructured implementation that instructors resort to instead of a more formalized and directed approach. It would appear that there is a gap in terms of guidance from the curriculum design as well as management, which allows the instructors to adopt a subjective and skewed implementation of LBD. This finding, therefore, reiterates the need for a model that can give clear open directions about LBD and the pedagogical approach suited to it.

6.2.3. THEME 3 – Comparative understanding of LBD practices.

The analysis of the two sets of data showed whether the students and the instructors had a shared understanding of what constitutes an LBD practice or whether individual LBD practices were being implemented or not. In most cases, as seen from the preceding discussions in this chapter, the instructors were facilitating some of the LBD practices to a certain extent but, inadvertently and with little or no knowledge of the fact that the given activity was an LBD practice or that they needed to encourage students to participate actively. This conclusion is derived from the perceptions emerging from the students' survey. The result of the research had shown that in most cases more than half the students perceived the LBD practices as being implemented, even when the instructors did not acknowledge in their interviews that they were aware of them or actively implementing them. The insight that is being repeatedly underscored is that instructors may be lacking in their understanding about the LBD approach and may not have clarity on implementation, something that may be addressed with the help of a new approach and model of LBD. The merging of the data sets also shows that students' and instructors' perceptions of "instructors conducting practices that allow

students to fully experience the topic" (Meyers & Nulty, 2009, p. 567) are not aligned. In many instances in the interview the data, the instructors stated that they had implemented this practice. However, the students' survey revealed that only a few students had perceived this practice being implemented.

While LBD requires instructors to develop and engage the students in practices that can allow them to fully experience the topic being taught, LBD literature does not give an exhaustive set of practices that can be undertaken (Meyers & Nulty, 2009). Field trips and workshops, visiting the factories and understanding their work processes first hand, and helping the students to see for themselves how concepts are practised are some of the practices that are mentioned in the literature (Bolstad, 2011; Lee & McLoughlin, 2007; Prensky, 2012). Four instructors had mentioned project work, lab work, factory visits, and industrial field trips. These are certainly some of the practices that can engage students more fully to learn the topic and to see it unfold in a real-life context. However, from the students' survey, the responses indicated that only 45.6% of the students believed that the instructor used various teaching methods or perceived that the 'instructors conducting practices that allow students to fully experience the topic' to encourage them to fully experience/understand the content that was being delivered during a class. This underscores the fact that a substantial number of students perceived the LBD practice was not being undertaken, though the instructors' interviews revealed several instructors indicating that this is being done. These findings are in contrast to the general trend that has been visible to the students perceiving they are being asked to do an LBD activity, but the instructors are not aware of implementing the practices. It is also interesting to note that the majority of the students seem not to perceive field trips, company visits, or project works as real-life practice with connections to LBD practices. It is therefore also possible that the instructors did not emphasize this connection to the students and all efforts and trips or projects, were performed by the students without a full appreciation of their intended learning.

An insight emerging from the merging of the two sets of data is that instructors are not sure of what they are teaching and how, and probably the students not sure about what they are learning and how.

It is anticipated that an improved model of teaching would enable more clarity for both the instructors and students by linking specific teaching content with the underlying 16 LBD practices and by empowering students to fully appreciate every aspect of their study and link it with the understanding of concepts and teachings. This illustrates the need for a model that is not just theoretically rooted in LBD literature, but which specifically links students to their future employers.

The discussion with the dean and the instructors of the institute identified several interesting insights about their understandings of LBD. One underlying theme was that there was a conceptual difference between how LBD was understood by the dean and how it was understood by the instructors. It was evident that the dean believed LBD to be more of a framework, a construct or a set of guidelines that were directed toward building qualities like "experiencing the learning", "doing reflection", and "conducting self-criticism". According to the dean, LBD is a vague concept and may include both conventional learning and lab or project work. On the other hand, the instructors were largely of the opinion that LBD constitutes projects, lab work, field trips which enable the students to understand the learned content so to be able to apply it in practice outside their classroom learning environment. So, both the instructors and the dean believed that LBD was concerned with imparting learning in a way that it is 'experienced' by the students, and that they can develop analytical, critical, and reflective ways of thinking.

These findings, therefore, appear to indicate that LBD may be understood by instructors and the dean in its main essence - that is, to develop students into active learners who can relate their classroom and theoretical learning to their everyday life as well as to their professions in future. Neither the dean nor the instructors were forthcoming on any clear definition of LBD, though the instructors offered that it involves enabling the students to construct the problem themselves and then enabling them to solve it through perseverance and application of critical thinking and reflective

processes. One instructor defined LBD as an "old concept". Another instructor defined it as "apply what you learn in the classroom to real life". The findings also reveal that neither the instructors nor the dean was sure about the methodology for LBD or its implementation, and largely put forward the reason that it was a rather abstract and vague concept to implement and even more so, to assess. Almost all respondents suggested the need for a clearer and more concise definition of LBD produced by the institution. These findings already hint at the rudimentary, and the unstructured or intuitive method by which instructors might be understanding and implementing LBD in their classes (as previously discussed in Theme 2). While there is a grasp of what LBD is expected to bring about among students – that is, an ability to engage with the theoretical content and to experience it in a practical and a personal manner - the data indicate that there is little understanding of how and what practices may lead to such propensities among the students.

This is in contrast to the literature where considerable clarity and insight is provided by several researchers (Clark et al., 2010; Dewey, 2009; Kolb & Kolb, 2005; Lewis & Williams, 1994) who give background and context to the development and implementation of an LBD curriculum and assessment of its practice within the classroom setting. As indicated in Chapter 2, in the literature, the concept of LBD is neither as vague nor as unstructured as suggested in the interviews of the dean and the instructors of the Institute. Moreover, LBD is not something that can happen by chance or on the basis of limited understanding, it can only happen successfully if the curriculum and implementation is consciously designed and planned meticulously (Ash & Clayton, 2004; Chan, 2011; Lewis & Williams, 1994; Morgado, 2010; Paulson & Faust, 2010).

This approach is further substantiated by Pascual and Uribe (2006) who specifically outlined the process of LBD that is best suited in the context of engineering students. This involves concrete learning objectives, such as developing decision-making, encouraging team working, developing autonomous learning, enabling students

to handle conflicts, and developing in them the ability to present and defend their initiatives.

6.2.4. Summary.

It can be concluded from the findings that, while the instructors and the dean, may have the conceptual and abstract understanding of the construct of LBD, this has not led to an appreciation that LBD needs to be supported by a structured framework for modeling and implementation in a structured and formal manner. This lack of appreciation of the connection between what is an abstract construct and its practical application is a problem as it results in an attempt to conceptualize, implement, and assess LBD practices meeting with limited success. Another problem that was detected from the research data is that different instructors emphasized different practices or approaches to what they believed would bring about LBD learning. This meant that each instructor might be implementing his or her version of an LBD approach and practices, especially as the instructors observed that the curriculum or the management had not provided any concrete and systematic guidelines for LBD. While a certain degree of customization and flexibility in implementation may be welcome, in the current case, it was not limited to just the instructors having the autonomy or flexibility in interpreting LBD and implementing related practices. The issue seems to manifest points to a deeper problem, one that questions the lack of concrete directions and specifications for the instructors to follow. Further, this section would not be complete without mentioning that while the instructors and the dean, did mention concepts like ‘experiential learning’, ‘reflection’, ‘self-criticism’, ‘critical thinking’ and ‘analytical thinking’ (as essential or core objectives of LBD), it was beyond the scope of this research to explore more deeply into their understanding of these concepts. What can be said is that the while the instructors and the dean were familiar with the terminology of LBD, they were not aware of what was specifically meant by the LBD terms or which practices or strategies could facilitate the related learning.

Furthermore, as stated earlier, there were often discrepancies between what the students perceived as happening in class and what the instructors intended with respect

to the implementation of LBD. These findings indicate the lack of understanding about LBD among students, and the onus of this may again be attributed to the instructors not being able to articulate what they were trying to implement in their classes. Frequently, there was no explicit understanding or implementation of an LBD practice – where both the instructors and the students shared an understanding of what was being done and what was being learned. The underlying themes that are seen to emerge from the interviews and surveys all point toward a degree of confusion regarding the nature and methods of implementing LBD. It is here that the need for a new model and a new approach to LBD in the target institute becomes apparent.

6.3. Themes Around the Current Implementation of 21st Century Skills

The second part of the research was focused on understanding if 21st Century Skills were being taught and assessed in the classrooms. The students were asked questions in a second survey, and the instructors and the dean were invited to share their perceptions on the issue during their interviews. This section presents the data collected from both groups presenting a comprehensive response to the question by merging both data sets (Figure 6.2).

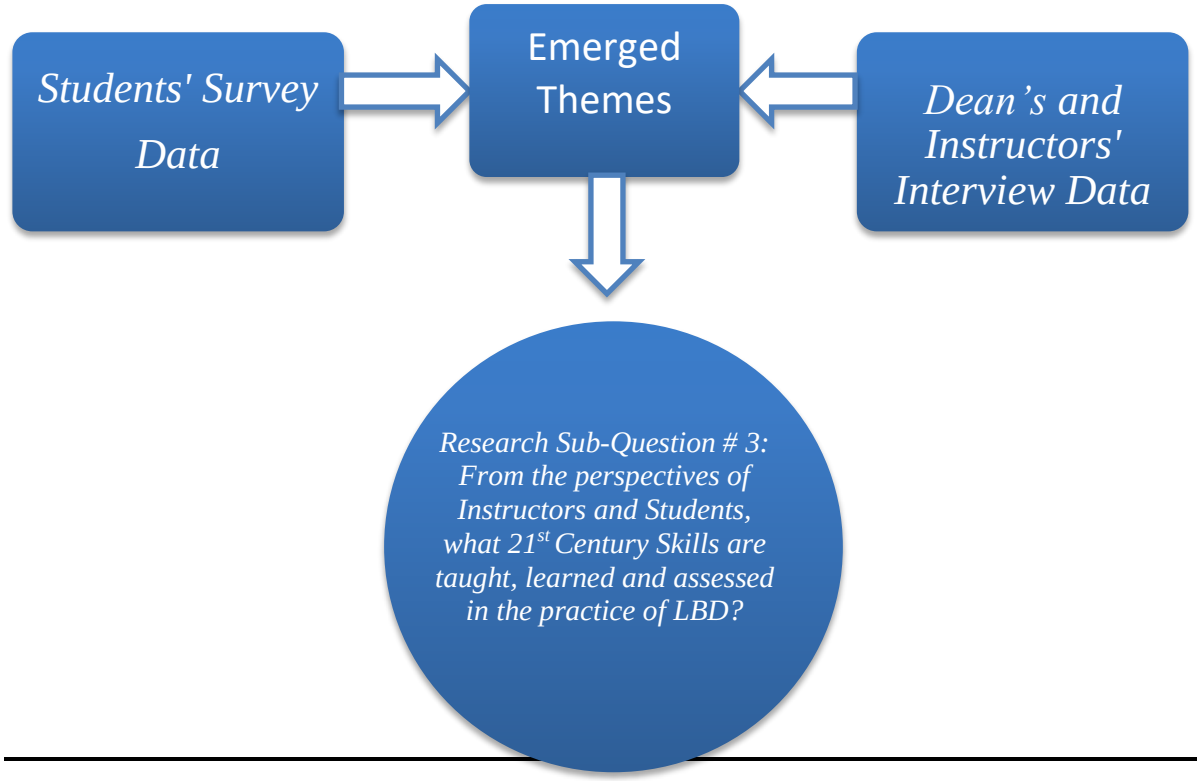


Figure 6.2. Themes around 21st Century Skills Implementation and Assessment

The 21st Century Skills framework (Kereluik et al., 2013) has been discussed extensively in Chapter 2. The following section discusses the themes that emerged related to the participants' perceptions of the success of implementation and assessment of the skills. Also, emerging themes related to the instructors' understanding of the skills are discussed.

Table 6.2 presents a summary of themes about the 21st Century Skills that emerged and their perceived effects and implications for a new model of teaching.

Table 6.2

Themes Arising from Merging of 21st Century Skills Data Sets

Themes	Findings	Perceived Effect	Implications To Consider for the New Model
THEME 4: Implementation of the 21st Century Skills	Lack of Guidance and Lack of Structure Implementing 21st Century Skills in a practical manner	All students not reaping the benefits of acquiring 21st Century Skills Instructors are not able to develop practices and approaches that enable them to impart all the 11 21st Century Skills	A model that enables instructors to deliver teaching so that all students can benefit from 21st Century Skills within the specific context of the Institute The need for a model that is not just theoretically rooted in LBD literature, but which gives specific guidance to instructors for imparting 21st Century Skills
THEME 5: Understanding of the 21st Century Skills:	Lack of in-depth understanding the teaching of the 21st Century Skills that could have guided the instructors better in the implementation stage.	All students not reaping the benefits of acquiring 21st Century Skills Instructors not getting the adequate conceptual understanding that is needed to underpin their teaching of the 21st Century Skills	The need for a model that could be inclusive for all students The need for a model that is theoretically rooted in LBD literature, and which gives clarity to instructors at the basic conceptual level
THEME 6: Comparative Understanding of 21st Century Skills between the instructors, dean and the students	Instructors did not have guidance or training to assess the skills that they were teaching. Instructors did not have guidance or training to teach the skills that they were assessing The instructors were not able to identify correctly what they were teaching and what they were assessing. The students were not able to adequately identify which skills they were being taught and which skills they were being assessed.	Students may be de-motivated to learn skills if they know they will not be assessed on them Instructors not able to develop strategies to make a proper and formal assessment of specific skills Instructors may not have the strategy, tools, or resources to impart the skills in a way that all students can learn them. Students may think it unfair to be judged on skills that were not being taught to them Instructors not sure what they are teaching and how Students Not Sure What they are learning and How.	A model that is not just theoretically rooted in LBD and 21st Century literature but which provides explicitly the instructors with the tools, resources and guidance, and very clear instructions for teaching and assessing the students on these skills

These three themes will now be individually considered in more detail.

6.3.1. THEME 4 - Implementation of 21st Century Skills.

The findings from both the students' survey and the instructors' interviews indicated that none of the eleven 21st Century Skills were being taught or assessed by all the instructors, and none of them were being perceived as being taught or assessed by all the students. This provides a clear indication that neither 21st Century Skill implementation nor assessment were carried out fully by all instructors. Therefore it could be implied that students were not benefiting from the inclusion of 21st Century Skills in their learning. For example, four instructors had mentioned 'Creative Skills' as a skill that they taught in class, but only two had mentioned that they were able to assess this skill. One instructor had added that he did not assess formally owing to the lack of a specific rubric provided to the instructors, though he assessed 'Creative Skills' informally. These findings are important, as they reveal that only four out of the eight instructors perceived they were teaching 'Creative Skill', and that only two were assessing it in any manner. Similarly, only 50% of the surveyed students indicated that they perceived 'Creative Skill' as being taught occasionally, and only 46.4% of the students mentioned that they perceived they were sometimes being assessed on this skill. The student survey data, therefore, corroborates the data that emerged from the instructor interviews.

This trend for partial implementation or assessment of the eleven 21st Century Skills is seen throughout the merging of the findings. In a technical Institute, it seems reasonable to expect that the instructors would have some understanding of the importance of encouraging their students to learn 21st Century Skills. However, the data indicate that this has not been the case. As a result of the partial implementation of the 21st Century Skills, all students are not reaping the benefits of acquiring 21st Century Skills.

It is also interesting to note that there were differences in the perceptions of the students regarding the teaching and assessment of specific skills. Students perceived

that at times, they were assessed but not taught, and they perceived at times that they were taught but not assessed. Such findings underscore a deeper issue related to the instructors being unable to develop practices and approaches that enabled them to impart all the eleven 21st Century Skills. There is also a clear need for a model that could be inclusive for all students, as well as enabling instructors to teach in ways allowing all students can benefit from 21st Century Skills.

In summary, it is evident that all students are not reaping the benefits of acquiring 21st Century Skills. Instructors are not able to develop practices and approaches that enable them to impart all the eleven 21st Century Skills. These insights indicate a need for a model that enables instructors to deliver teaching so that all students can benefit from 21st Century Skills. There is a need for a model that is not just theoretically rooted in LBD literature, but which gives specific guidance to teachers for imparting 21st Century Skills.

6.3.2. THEME 5 – Understanding of 21st Century Skills.

During his interview, the dean did not dwell on each skill though he appeared to be knowledgeable about the 21st Century Skills framework. He also showed an understanding of each specific skill and suggested that the skills are being taught some of the time in the classes. However, there was also an implied assumption in his answers that the onus of teaching these skills lay firmly on the shoulders of the instructors – and that the Institute or the administrators could do little in that respect. According to the dean, it was the task of the instructors to implement and assess these skills. He further mentioned his awareness of gaps in the assessment areas, suggesting that the instructors were not able to demonstrate an ability to assess the 21st Century Skills. He went on to suggest several ways in which the instructors might succeed in assessing skills, including teamwork assessments, assessment of students' ideas, and assessments of students' flexibility in approaching problems. However, the dean acknowledged that the assessment of 21st Century Skills is challenging to structure and implement.

The dean's responses indicated that the lack of concrete direction and guidance provided to instructors might explain, to a certain extent, why they may be having issues implementing and assessing the 21st Century Skills. The underlying theme that has emerged is that there is a lack of understanding of the 21st Century Skills, especially in the context of their implementation and assessment. This presumption of the limitation of the management or the dean's role in directing the implementation has resulted in lack of guidance and lack of structure (in the curriculum framework and teaching model) in practically implementing 21st Century Skills. As a result, as the merging of the data sets has amply displayed, all students were not reaping the benefits of acquiring 21st Century Skills.

Additionally, these findings indicate the need for a model that is not just theoretically rooted in LBD literature, but which specifically equips students with the 21st Century Skills that will enable them to perform in the engineering industry in the future. Also, as the instructors appear not to have the conceptual understanding needed to underpin their teaching of the 21st Century Skills, there is a need for a model that is theoretically rooted in LBD literature, and which gives clarity to instructors at the basic conceptual level.

6.3.3. THEME 6 – Comparative understanding of 21st Century Skills.

A broad theme that emerged from the merging of the two data sets was that there were substantial differences in the perceptions regarding the individual 21st Century Skills. Three sub-themes seem to correspond to this basic theme: first, that a given 21st Century Skill was perceived by students as taught but not as assessed; second, that a given 21st Century Skill was perceived by students as assessed but not as taught; and third, that there was substantial disagreement between the students and the instructors over whether a particular 21st Century Skill was being taught or assessed. The following sections, therefore, elaborate on each of these sub-themes.

One trend that was observed from the responses was that several skills were perceived by students as being taught but not as being assessed by their instructors. The reasons for this could be a lack of understanding of the link or connection between skills like 'Creative Skills' and engineering-specific learning outcomes for students that may be assessed in terms of 'Creative Skills'; or the possibility that instructors may not be inclined to assess the students on their 'Creative Skills' simply because they may not envisage engineering and creativity together. A similar result was observed in the context of 'Communication Skill', which is an integral part of any educational model. Data from the students' survey show that 65% of the student respondents believed that they were being taught the skill to communicate, while only 55.3% of them thought that they were being assessed on the same skill. Communication was not identified by most of the instructors as a skill that needed to be taught or assessed – which reinforces the theme that most skills were partially implemented (Theme 4) and further, that some were taught more than they were assessed. It can be asserted that in an engineering program, it is vital that students learn how to work as a team. The data collected from the students revealed that more than 73.8% of the students stated that 'Teamwork' was being used. While only 28% of the students and two-thirds of the instructors perceived it as being assessed, these students' findings are in alignment with the trend from the instructors' data – the skill is taught more but assessed less. A similar trend was observed for other skills like 'Ethical Behavior' and 'Innovation'.

These findings indicate that probably neither the instructors nor the students were aware of how the teaching was linked to a specific skill set development. Also, the fact that these skills were being perceived as taught more but assessed less, often suggests the possibility that the instructors did not have guidance or training in the assessment of the skills that they were teaching.

The second trend that was captured during data merging was that some skills, like 'Collaboration Skill', were perceived as assessed by more students than reported as being taught. The students' survey showed that only 53% of the students saw themselves as using collaboration in learning practices at least occasionally, while almost 61% of

the students believed that they were being assessed on this skill. Two things can be noted from this – one, that only a little over half the surveyed students perceived that they were being taught Collaboration Skills; and two, that more students perceived they were being assessed than those who thought that they were being taught. This is an interesting finding, especially when read in conjunction with the instructors' responses, since fewer instructors mentioned assessing this than those who mentioned teaching it. Somehow, it appears, that a considerable number of students felt that they were being assessed – though the instructors were not formally or actively assessing this skill. The reason behind this could be the nature of engineering class tasks which probably require students to work in groups or pairs– and which could be interpreted by the students as being an assessment of their collaboration skills. A similar trend was observed for the 'Critical Thinking' skill, 'Life Skills', and 'Problem Solving' skill.

The underlying reasons for the confusion as well as the lack of implementation of these skills in class can again be traced to a system where the instructors are not formally and technically made aware of the importance and linkages of 21st Century Skills in the students' ultimate learning; and where the existing LBD practice was not there to guide the instructors in its implementation and assessment. A potential problem emerging from this discrepancy was the possibility that if the students perceive they are being assessed on something, but not being taught that skill, then they may feel some resentment or demotivation. The literature on motivation indicates such outcomes (Meyers & Nulty, 2009).

The third trend that was noted was the lack of correlation between the students' and the instructors' perceptions of skills being taught and assessed. For example, 65.2% of students and only 4 out of 8 (that is, 50%) of the instructors perceived that the 'Communication Skill' was being taught in class, and only 55.3% of students and only two out of eight instructors (that is, 25%) perceived that they were assessing students on this skill. This trend of non-agreement between students and instructors is apparent across almost all skills. For example, all instructors except one had mentioned that they taught the 'Collaboration Skill' in class, but the students' survey showed that only 53%

of the students see themselves as using 'Collaboration Skills' in learning practices. Also, while only one instructor mentioned assessing students formally as per a rubric, 61% of the students believed that they were assessed on the skill. 'Teamwork' was recognized by 73.8% of the students and all but one instructor as being taught in the class, while only 28% of the students and five out of eight instructors perceived 'Teamwork' as also being assessed by the instructors. Only three instructors (Instructors 3, 4, and 5) mentioned teaching the 'Critical Thinking' skills, while 45.7% of the students perceived this was being taught; one instructor mentioned assessing this skill with the use of a rubric, while 57.1% of students mentioned being assessed on this skill in class.

In the same manner, while the 'Problem Solving' skill was mentioned by almost all of the instructors as being taught and assessed, only 56.8% of the students believed that they were being taught this skill. It is worth noting that 96.6% of the students believed that they were being assessed on this. Also, 'Innovation' was explicitly mentioned as a skill taught by three instructors, though none of the instructors mentioned assessing this skill in any formal manner based on a rubric. It could be inferred that a majority of the instructors may not be encouraging students to learn 'Innovation Skills' or to come up with innovative ways of problem-solving – though the students believed that they were being taught to be innovative. These findings indicate the gaps in the curriculum design, and teaching model practiced at this institution – as neither the instructors nor the students were aware of how the teaching was linked to a specific skill set development.

6.3.4. Summary.

The merging of the data on the 21st Century Skills has revealed the gaps that may be filled by the proposed new model. It is evident from the merging of the data sets that there is only partial understanding of the 21st Century Skills among the instructors, leading to the partial implementation of these skills, and that not all students seem to be aware of being taught or assessed on them. None of the instructors taught all the 11 skills and not one of the 11 skills was taught by all the instructors. Also, further analysis of the merged data sets revealed a considerable difference in the way these skills were

being perceived by the students, instructors, and the dean. Certain skills were being perceived as taught but not assessed by the students, indicating the likelihood that the instructors were not assessing the skills. As they had acknowledged in the interviews, this could be because they believed that the skills were vague and not amenable to formal assessment, or because they may not have received any guidance or direction on making assessments.

The merging of the data has shown that several skills were not mentioned as either taught or assessed by instructors, but the same skills were perceived by the students as being taught or assessed. For example, 'Collaboration Skill' was mentioned as being taught by all except one instructor, but the same was being reported as being taught by only half the surveyed students, and while 73.8% of the students perceived being taught 'Teamwork Skill', only one instructor mentioned it as being taught, while 5 out of 8 instructors said they assessed 'Teamwork' and only 28% of the students believed that they were being assessed on it. So, there are reasons to believe that there are gaps in the existing LBD practices and 21st Century Skills implementation at the Institute. As seen from Table 6.2, the merging of the two data sets has revealed several themes that need to be addressed by a new model. It is seen that the current practice and followed model are probably not well understood by the management as well as the instructors, and do not equip the instructors with specific guidance or instructions to facilitate full implementation and assessment. These issues are, therefore, the focus of the next section that lays the groundwork to shape the new model that will be proposed in the next chapter.

6.4. Developing a New LBD Model of Learning at the Institute

This section is dedicated to developing a set of principles that will reinforce the development of the proposed new model (Figure 6.3).

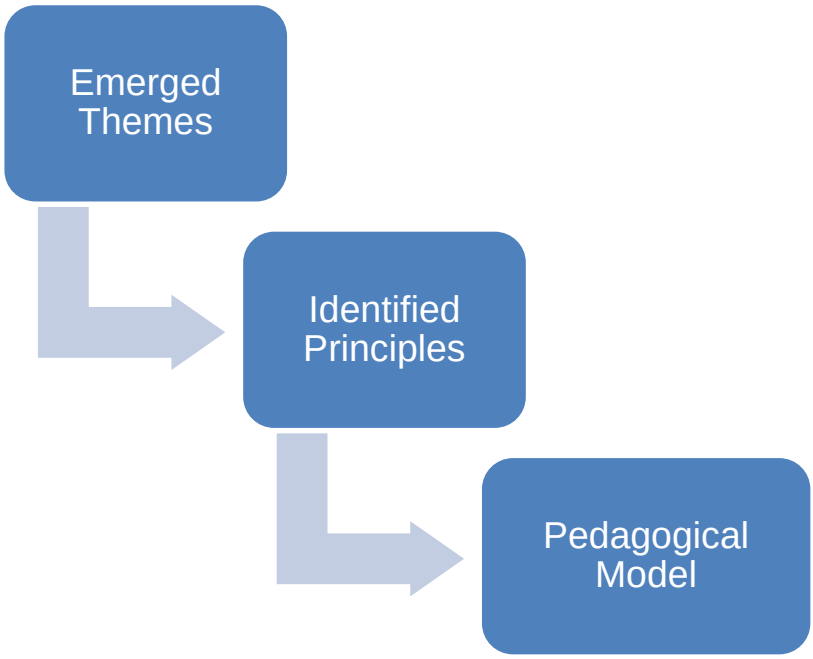


Figure 6.3. Merging Data Sets to Evolve the New Pedagogical Model

The themes that were obtained from the merging of the data sets have led to the identification of several limitations in the existing pedagogical approach regarding both implementation and assessment of LBD practices and 21st Century Skills at the target Institute. These limitations now become the focus of attention, as this section aims to identify the principles emerging from the themes, that will guide and strengthen the development of the proposed new pedagogical model. Merging the results from the two sets of data has revealed that the majority of LBD practices and 21st Century Skills were not being practiced (taught or assessed) by the instructors in a conscious, deliberate, structured, organized or concrete manner. The students were also found to be not fully aware or able to confirm if they were being taught using LBD practices or 21st Century Skills.

The current LBD practices as described by the engineering instructors at the Institute can, therefore, be considered as limited in their ability to provide a structure, detail or guidance for the instructors to implement these practices and skills. There is, therefore, a compelling argument for developing a new pedagogical model to better support the implementation of LBD practices and 21st Century Skills. The principles

have emerged from the themes already discussed in support of the limitations of the current knowledge and practice of the dean and the instructors. The principles have been defined and subsequently have guided the scope, as well as the content of the proposed new model. Firstly, Figure 6.4 highlights the themes and the corresponding limitations that were revealed.

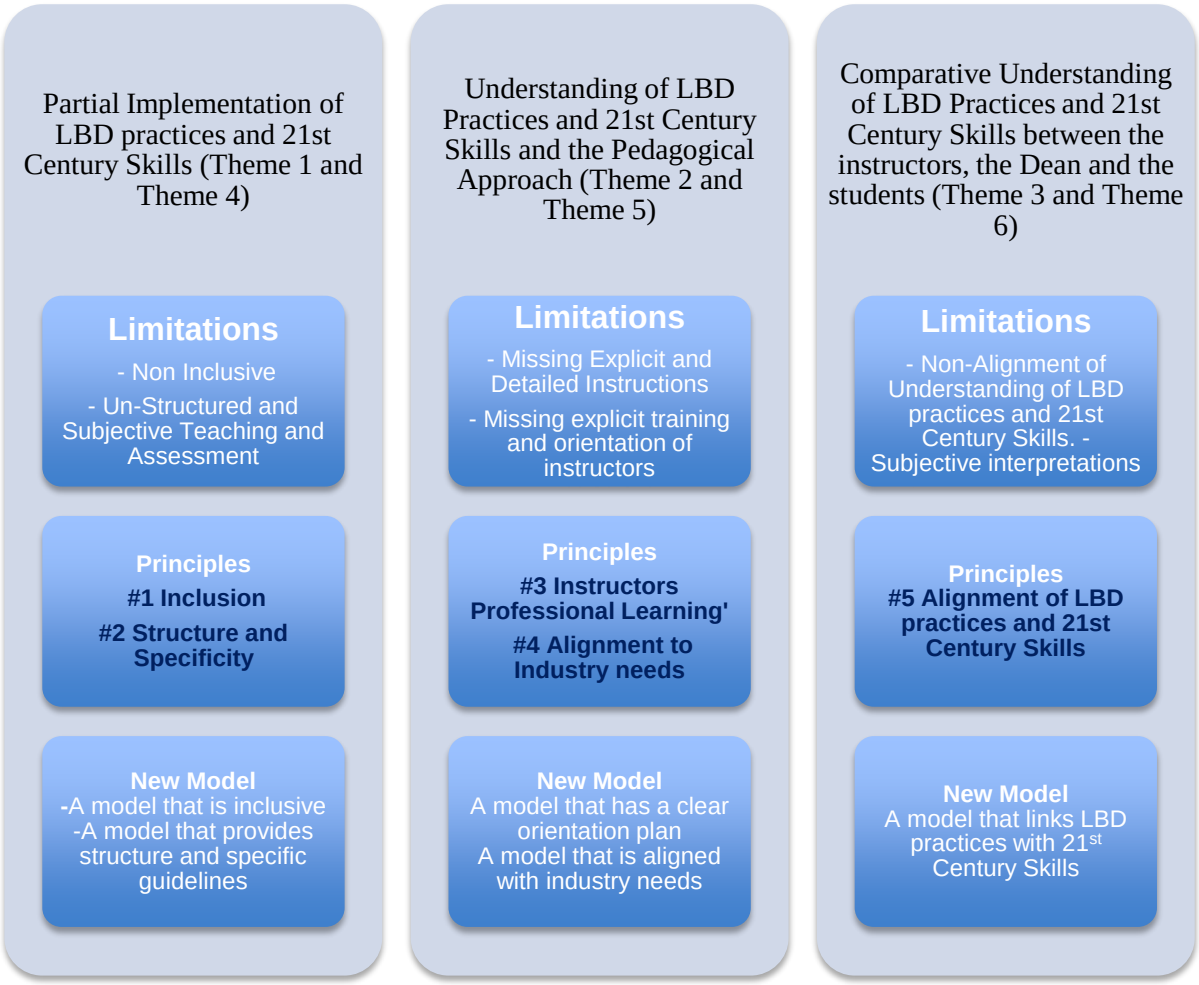


Figure 6.4. Five Principles Derived from Emergent Themes

Five principles have evolved from the deeper understanding of the implications revealed in the discussions of each of the themes. The following section further elaborates on the development of these principles, which later form the basis of the proposed new model presented in chapter 7.

PRINCIPLE #1 – Principle of Inclusivity

To engage all students in the full range of LBD practices and learn 21st Century Skills.

Themes 1 and 4, which form the basis for the first principle, underscore the fact the instructors did not mention most of the 16 LBD practices or 11 21st Century Skills. The implications are that the LBD practices (whichever were being implemented at whatever frequency) were not successful in engaging at least 30% of the students. Hence, there was a need for developing a model of LBD that could successfully involve 100% of the students in any given session. A similar trend was observed when the data were merged for the 21st Century Skills, where it was noted that none of the instructors taught all of the 11 skills, and none of the 11skills were being taught by all the instructors. The overall insight that emerged is that LBD practices and 21st Century Skills are neither being taught universally by all instructors nor being perceived or learned by all students. The current approach to teaching, therefore, lacks inclusion. As such, a new model needs to proactively ensure all students participate.

PRINCIPLE #2 – Principle of Structure and Specificity

To provide a structure and specific directions for ensuring that LBD practices and 21st Century Skills are taught explicitly and the students can benefit from them with a clear understanding of what they are learning.

Themes one and four also revealed the limitations between the dean and the instructors in their understandings of LBD practices. Similarly, Theme 6 also showed the lack of understanding of 21st Century Skills by the instructors, although interestingly, the dean had shown a greater degree of knowledge. However, the difference between the dean and the instructors, according to the data is apparent; and as such, it is manifested in the differences of understanding of the LBD practices and 21st Century Skills.

The data has revealed a substantial amount of individuality in the way instructors, and the dean understands and interprets LBD. It is proposed that this

subjectivity can be reduced or eliminated if there is a teaching model that gives greater clarity to the instructors and provides them with structured and specific guidance about implementation. It is important to have a formal model of delivery that enables the instructor to know, from beginning to end of each session – how and when students can engage in LBD practices. This second principle would guide the development of a new model that could give clear, specific, and comprehensive guidelines to the instructors so that they can undertake LBD related practices in a formal and accountable manner.

PRINCIPLE #3 – Principle of Professional Learning for Instructors

To orient the instructors as to the conceptual meaning and practical implementation of both LBD practices and 21st Century Skills.

Theme 2 and Theme 5 pointed to the limited understanding of LBD practices or 21st Century Skills among the instructors. These themes highlighted the disparity of perceptions of LBD practices and 21st Century Skills within the instructor group, between the instructors and the students, and between the instructors and the dean. These themes all point to one basic revelation which is being construed as a lack of clarity about both constructs, that is, concepts and practical implementations of LBD practices and 21st Century Skills.

These findings emphasize the need for professional learning for instructors so they may develop a core understanding of LBD practices and 21st Century Skills. Instructors may also require training regarding the implementation of LBD practices and 21st Century Skills. The principle that emerges is, therefore, to develop a model that is accompanied by a detailed professional learning program for the instructors.

PRINCIPLE #4 –Principle of Alignment to Industry Needs

To equip the students with the competencies and skills that support the industry needs.

Themes 2 and 5 have further highlighted the confusion in the way LBD practices and 21st Century Skills are delivered, assessed, and aligned to the needs of the industry.

The data shows that the students tend to perceive that they were being taught but not assessed on a particular skill; while on another skill they were being assessed and not taught. While this could indicate discrepancies in the way instructors seem to approach the delivery and assessment of the skills, a more significant problem that is perceived is the lack of clarity on how the LBD practices and 21st Century Skills contribute to not just the academic learning, but to the future job needs of the students. It is essential that such connections be established through the creation of course content that is relevant and credible and streamlined with the requirements of the industry. The principle of alignment with industry needs, therefore, is expected to guide the development of the model that has content at its core which is aligned with the knowledge, skills, and practices that are needed by students when they go out into the workplace.

The overall findings and more specifically the development of Themes 2 and 5 suggest the need for more exploration of this alignment. In the context of the current study, it can, however, be presumed that an underlying principle for any teaching model should have direct, clearly-defined, and tangible links with the industry requirements. This might be achieved through constructive alignment with industry projects using real-life case studies and a holistic assessment.

PRINCIPLE #5 –Principle of Alignment of LBD Practices and 21st Century Skills

To align LBD practices with 21st Century Skills

Emerging from the data sets, Themes 3 and 6 indicate the need for a new model that represents a complete understanding of how to implement LBD in the 21st century. As outlined in Figure 6.2, the two themes highlighted the considerable discrepancy in how the instructors understood LBD practices and 21st Century Skills and how the students perceived them. The data conclude that there was a lack of connection between LBD practices and 21st Century Skills and their implementation for assessment. A model is needed that will allow instructors to comprehend the pedagogical approaches and techniques required to implement the various skills using LBD across all engineering sections of the Institute.

Furthermore, what is needed is a model that can enable all parties involved to merge all areas without misunderstanding. The new model, therefore, needs to be guided by the principle of complete alignment between LBD practices and 21st Century Skills, leaving no scope for misunderstanding or misconceptions. This principle would enable the exact mapping of each 21st Century Skill with LBD practices and provide directions for the instructors to use them in their teaching and assessment practices.

6.5. Summary

This chapter emerged as a crucial part in the study as it identified the outcomes of merging the two sets of data from the interviews of the instructors and the dean and the survey of the students. The merging of the data led to the development of six broad themes, which highlighted an urgent need to address the limitations in the existing model of LBD used at the selected Institute. These themes indicate that instructors have a limited understanding of both LBD practices and 21st Century Skills. It might, therefore, be interpreted that the present curriculum and framework, as implemented by the Institute, do not sufficiently guide the instructors to teach or assess the LBD practices and 21st Century Skills. The themes also indicate that there is a need for improved organization, structure, and guidance for the instructors so that they can teach and assess their students more effectively. The themes provided the basis for the development of the five principles, which will form the groundwork of the proposed new model. A review of the literature in Chapter 2 highlighted several models that already exist, and the next chapter endeavors to use that knowledge, together with the five principles of this study, to create a new model in an attempt to meet the needs as highlighted in this chapter. The culmination of the current chapter in the form of the development of five principles is therefore expected to lead to the development of the proposed new model in the following chapter.

CHAPTER 7: DEVELOPING A NEW LBD MODEL

7.1. Introduction

Discussion in Chapter 6, based on a combined understanding of the students', the dean's and the instructors' perceptions, has led to an appreciation of gaps in the current methodologies and approaches adopted by the Institute under study in its LBD and 21st Century pedagogy. The Institute appeared to be employing a linear, traditional information transmission model of learning, which was manifested in the way instructors seemed to think about and understand LBD practices and 21st Century Skills. The merging of the students' findings with that of the instructors and the dean brought forth the idea that most of the instructors thought that LBD practices and 21st Century Skills represent abstract constructs that are difficult to teach or assess. Predominantly, there was limited understanding of the concepts and a lack of knowledge about the practical methods that can be used to implement these concepts of LBD and to develop 21st Century Skills. More specifically, themes emerged which were used in the development of the five basic principles that are used in this chapter to guide the proposed new LBD model and answer the overarching research question for this study:

> *What constructively aligned Learning-By-Doing (LBD) pedagogical model, incorporating 21st Century Skills, can be developed for enhancing the teaching of engineering at HCT, UAE?*

Based on the merging of data in the previous chapter, identified in Figure 6.4, it was found that the existing model of teaching was not aligned with the needs of the industry and did not exhibit an explicit alignment between specific LBD practices and development of 21st Century Skills. These findings led to the development of Principle 4 (Alignment to Industry Needs) and Principle 5 (Alignment of LBD and 21st Century Skills). These two principles have, therefore, guided the development of the new model

by ensuring that it explicitly links LBD practices with 21st Century Skills, and will be closely aligned to the industry needs.

It also emerged that most LBD practices and 21st Century Skills were being implemented in an ad hoc manner and in a subjective way which at times made it difficult for students to recognize that they were being taught or were being assessed on specific skills. The underlying reason was found to be lack of guidance (in the form of instructors' professional development, or direction by management) on how to teach or assess; as well as lack of guidance from the curriculum or the rubric that would enable the instructors to teach in a standardized and structured manner. This finding led to the development of Principle 2 (a model that provides a structured approach with specific guidelines for teaching and assessing) and Principle 3 (Instructors' professional learning). These two principles have, therefore, been used to guide the development of the new model.

Another theme that emerged was that not all 21st Century Skills or LBD practices were being taught or assessed, and not all students were aware of learning them or being assessed on them. As such, the current mode of teaching appears to be non-inclusive and not benefiting all the students. This underscored the need to develop Principle 1 (Inclusivity), which has guided the development of a model that enables more comprehensive and explicit teaching and assessment to engage and involve all students.

A model is, therefore, proposed in this chapter, which uses the five Principles that evolved from the analysis of the research data. More specifically, this chapter has aimed to develop a model that could guide the engineering instructors (Principle 3) in the use of specific practices to ensure that they consistently engage and involve all students (Principle 1) in industry aligned learning (Principle 4), through LBD practices aligned with 21st Century Skills (Principle 5) by teaching in a structured and effective manner (Principle 2). This model has been developed to be able to map specific LBD practices with 21st Century Skills learning (as guided by Principle 5: Alignment of LBD activities with 21st Century Skills) and provides explicit implementation guidance for instructors, as indicated by Principle 2 (Structure and Specificity). This has required the

model to have a staged approach for LBD practice and 21st Century Skill development activity so that the instructors can follow while imparting subject-based knowledge to the students, which is in keeping with Principle 2 (Structure and Specificity). Also, as per the guidance of Principle 3 (instructors' professional learning), the instructors need to be given access to practical tools and skills that they can use to implement the objectives of the LBD model of learning and enable the students to orient and align themselves with the specific needs of the industry. It also needs to be identified that there is a need for a professional development and training module, to accompany the LBD model, ensuring that the instructors are oriented in the concepts and constructs of both LBD practices and 21st Century Skills, though the development of such a module is beyond the scope of the current study.

The following section deals with the development of a model that draws from existing literature on well-known and tested models of learning and maps LBD practices with 21st Century Skills in a way that addresses the five Principles. It discusses the alignment of the five Principles with the foundational theories developed by John Dewey (1938), David Kolb (1984) and Kurt Lewin in (Marrow, 1977). This alignment of theory and practice underpins the development of the proposed new LBD model and responds to the overarching research question for this study: "What constructively aligned Learning-By-Doing (LBD) pedagogical model, incorporating 21st Century Skills, can be developed for enhancing the teaching of engineering in the Higher Colleges of Technology, UAE?"

7.2. Five Principles Guiding the Development of the Proposed New LBD Model

This section develops the new Model that is being proposed for the target institute. It draws on the five principles discussed in chapter 6 and identified in Figure 6.4. As a starting point for the development of the Model, the theoretical underpinnings of Dewey's (1938) cycle of trying and experience. Kolb's (1984) experiential learning that links theory and practice and Lewin's field theory and the concept of life space work (Marrow, 1977) are taken into consideration. These theoretical underpinnings

guide the emerging structure and format of the proposed new model. The three theoretical models are used because of their foundations in experiential learning philosophy where experience and a hands-on approach provides an opportunity for students to explore, share and reflect on their experience to develop new skills, develop a new way of thinking and new knowledge (and are thus compatible with Principle 5 Alignment of LBD practices with 21st Century Skills). Additionally, the proposed model is built on the premise that the learning cycle is an "endlessly recurring process of exchange between the learner's internal world and the external environment" (Kolb & Kolb, 2018, p. 80) and suggests specific steps when tackling a presented problem or particular challenge to acquire and practice 21st Century Skills, thus aligning with Principle 2 of Structure and Specificity.

Kolb's (1984) Learning Cycle provides a useful starting point for the development of the new model due to its underlying premises which seem to be aligned with Principle 5 of Alignment of LBD practices with 21st Century Skills in terms of the emphasis on experiential learning and reflection-based learning to develop skills. According to Kolb (1984), learning is an ongoing process that continues to happen as people experience and reflect on life. Kolb's Learning Cycle consists of four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. According to these stages, an individual first needs to have an experience, be it in a classroom setting or a real-life situation. This experiential encounter then enables the individual to reflect upon what he or she went through, and subsequently to develop some theories, abstract concepts or hypotheses as a result of reflection and thinking. In the final stage, the individual tests his or her learning or hypotheses in different situations to fine-tune their hypotheses or to re-define their concepts. People can be observed using this approach in their daily lives in a natural way that often functions on a subliminal level. The current study takes cues from this model's four stages, and also postulates that the new learning model needs to be a stage-based model. As such, the new Model is conceptualized as a stage-based model, that closely follows Kolb's cyclic approach, but with several refinements using insights from other theories and models as well.

The new model also borrows liberally from the elements in Dewey's (1938) approach to learning, which asserts that engagement and experience with learning opportunities should form an essential part of learning (thus being aligned with Principle 5 of Alignment of LBD practices with 21st Century Skills). Dewey also stresses to link the new learning with past learning to apply the knowledge in new contexts in the future (which makes it aligned with Principle 4 Alignment with industry needs), and reflection. As such, the four stages of learning according to Dewey's model are: active, experiential learning; assimilation of the new learning and its alignment with the prior learning; experimentation or testing of the new learning in future-oriented scenarios; and finally, reflection. These stages are aligned with Kolb's four-stage model (see Table 7.1), as well as incorporated into the proposed new model.

Finally, the proposed new model follows the premise created by Lewin (Marrow, 1977) that learning occurs as a result of the interaction between the learner and their environment, thus adhering to Principle 1 Inclusivity and Principle 5 Alignment of LBD practices with 21st Century Skills. Moreover, it can happen if the learner is actively engaged and motivated and able to explore the environment and resolve conflicts (which is compatible with Principle 1 Inclusivity).

Table 7.1 captures the amalgamation of the three theoretical models and the five Principles, to provide the essential, actionable components of the proposed new model.

Table 7.1

Theoretical Underpinning of the Proposed New Model

Principles	**Kolb**	**Dewey**	**Lewin**	**Proposed New Model**
Principle 1 Inclusivity	Reflective Observation Concrete Experience	Reflection Experiential Learning	Interaction between person and environment	EXPLORE DO REFLECT
Principle 2 Structure and Specificity	Concrete Experience	Experiential Learning		EXPLORE DO REFLECT
Principle 3 Instructors' professional learning				Professional learning Professional development and Training Module
Principle 4 Alignment with industry needs	Abstract Conceptualization Active Experimentation Reflective Observation	Past Learning linked with current Current learning linked with future Reflection	Interaction between person and environment	EXPLORE DO REFLECT APPLY
Principle 5 Alignment of LBD practices with 21st Century Skill	Concrete Experience	Experiential Learning	Interaction between person and environment	EXPLORE DO REFLECT APPLY

The proposed LBD Model is therefore profoundly situated within the frameworks that have already been developed by other scholars and tested successfully

as part of experiential learning curricula. As mentioned earlier, there is a plethora of literature in the context of LBD and its implementation, but as this research has found, there is a lack of contextual understanding and guidance for implementation within the target Institute – thus the proposal of a new model. The model will follow a staged format similar to those used in the theoretical frameworks of Kolb, Dewey, and Lewin by using the terminology of "Explore", "Do", "Reflect", and "Apply". The next section outlines the development of the proposed new Model in detail and further provides the linkages with the five Principles.

7.3. The Proposed New LBD Model – Description and Discussion

The proposed new model is set as a staged model, underpinned by the theories of Dewey, Lewin, and Kolb, and guided in construction by the five principles as determined within this study.

This section will develop the first stage of the proposed new model to comply with the principles as outlined in Figure 7.1.

7.3.1. Stage 1 – EXPLORE.

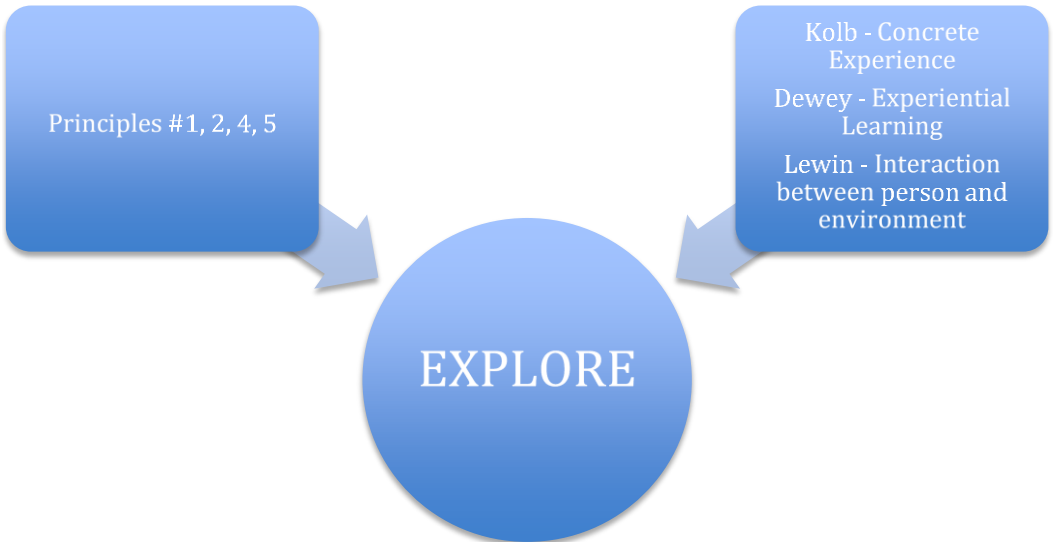


Figure 7.1. Stage 1 – EXPLORE: Link with Principles and Theoretical Models

Using Kolb's approach, the Model is multi-staged. It begins with the EXPLORE stage. This first stage of familiarization with experiences (Kolb's Concrete Experiences) is better understood and manifested in a classroom setting if it is defined as 'active exploration'. Defining the first stage of the model as 'explore' adds a sense of empowerment to the process of learning, and positions it as an active process rather than a passive or natural process as contended by Kolb (1984). While Kolb's model postulates experiences or opportunities to propel learning as almost a natural phenomenon and happening by default, my model emphasizes the active, conscious and guided experiences of students at the onset of their learning cycle. The active engagement of students with the concepts, therefore, forms the first stage of the model in the form of exploration. The proposed new model is expected to set the guidelines as well as provide specific instructions for the instructors related to the implementation and assessment of this exploration stage. This is also in tandem with Dewey's approach of using an experiential approach to initiate learning. Students are introduced to and allowed to explore the learning content.

This stage also takes into consideration a fundamental tenet of Lewin's model (Marrow, 1977) – the interaction between the learner and environment. This allows the learner to experience the environment, becoming stimulated to think and explore actively.

Therefore, Stage 1 EXPLORE is based on the presumption that real-world experience offers opportunities for students to construct and organize knowledge, and as such, an essential part of learning involves allowing the students to freely explore and engage themselves in detailed research about each topic that is introduced to them. The curriculum is structured in a manner that is aligned with the needs of the industry, thus adhering to the Principle 4 of Alignment with industry needs. This also fulfills the Principle of Inclusivity, by ensuring that all students are involved in the process of exploration. The exploration part of learning can be facilitated by the instructor as well as through a diverse set of learning resources that can be made available to the students. These include traditional lectures, self-discovery (pre-reading), or group learning

through open-ended discussion. Once the topic has been introduced, the instructors can bring their unique understanding of the concepts to the table, link it to the students' prior learning, and extrapolate it to concepts and practicalities of real life. The Model ensures that the Principle of Instructors' Professional Learning guides the development of the instructors' understanding and competencies, to ensure that they can facilitate the process of exploration. Also, at this stage, while it is advisable to be flexible in the approach to teaching and allow the students to experience the learning in their unique way, the Principle of Structure and Specificity still applies as it guides the instructors and enables them to provide their students with guidance and direction on how to explore the content. The students can engage with content available online, through library resources and secondary readings. They can also be encouraged to generate questions, inquire about the logic underpinning what they learned, and develop newer connections between diverse ideas and constructs related to the topic. Moreover, when the student begins the learning cycle with active exposure to a range of experiences, it begins the process of initiating several LBD practices and gives instructors the opportunity to actively teach the associated 21st Century Skills (see Table 7.2), which align this stage with the Principle of Alignment of LBD practices and 21st Century Skills.

The selection of these specific LBD activities for the EXPLORE Stage was made based on the premise that these LBD practices aim to facilitate exploration. For example, the first LBD practice listed in Table 7.2, "The instructor uses real-life case studies as a means for teaching the content of the course" is expected to encourage students to explore and interact with the course content in diverse settings. Similarly, the practice, "The instructor uses simulation either digitally or manually as a means of teaching a concept" again encourages students to see the course content from diverse perspectives and hence facilitate exploration. This logic is applied for all stages of the proposed new model, where a set of specific LBD practices is selected to illustrate the expected activities of the particular stage.

Table 7.2

Stage 1 – EXPLORE: Related LBD Practices and C21st Skills

LBD Practices	C21st Skills
5. The instructor uses real-life case studies as a means for teaching the content of the course.	Creativity Communication Collaboration Team Work
7. The instructor uses simulation either digitally or manually as a means of teaching a concept.	
8. The instructor demonstrates a required subject skill first, then asks the students to follow suit.	Critical Thinking, Cultural Sensitivity Ethical behavior, Life Skills
12. The instructors conduct activities that allow students to experience the topic thoroughly.	Problem Solving Innovation Computer Literacy
14. Classroom activities that require the students to model experiences or concepts.	

Figure 7.2 highlights the first stage of the proposed model as the EXPLORE Stage. It shows the alignment of this stage with the specific steps of three different theoretical models, as supported by the principles. The figure also depicts the specific LBD practices and the 21st Century Skills that are to be the focus of this stage of teaching/learning (as mapped in Table 7.2).

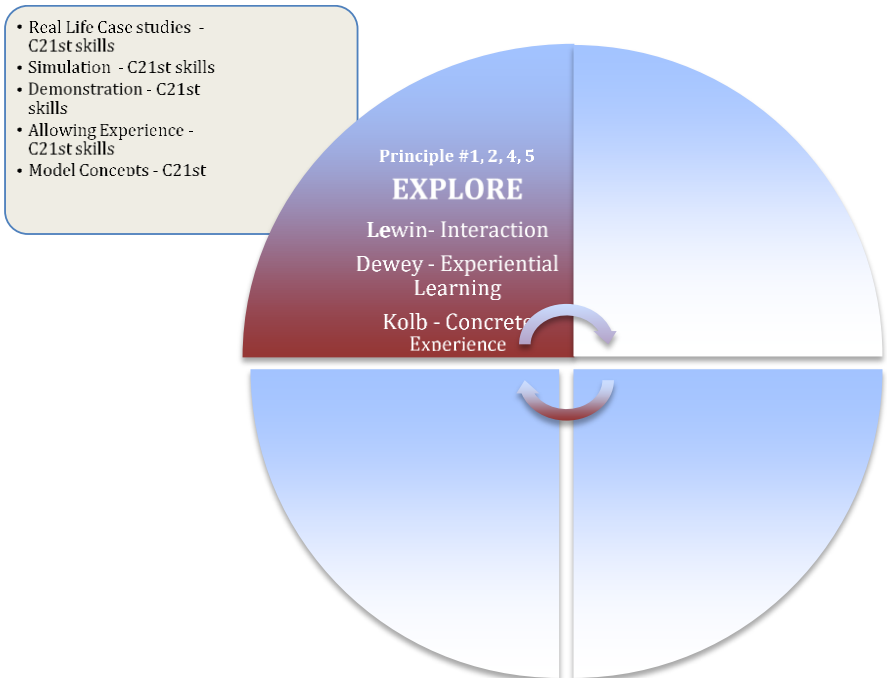


Figure 7.2. Stage 1 – EXPLORE Stage of LBD Model

7.3.2. Stage 2 – DO.

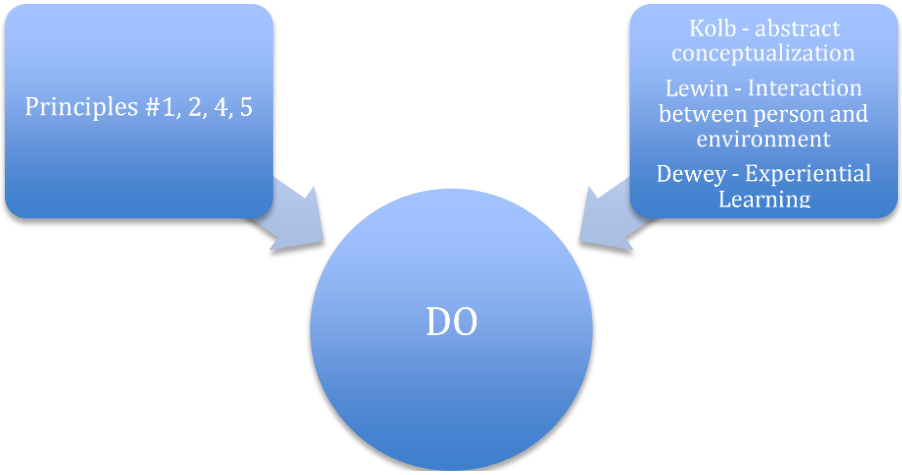


Figure 7.3. Stage 2 – DO: Link with Principles and Theoretical Models

The second stage of the Model is 'DO', which is the equivalent of 'active experimentation' and, to a certain extent, of 'abstract conceptualization' in Kolb's (1984) model. However, while Kolb positioned it as the third stage of the learning cycle,

this new Model uses it as the second stage. I believe that the DO stage is better placed immediately after the EXPLORE stage because the students' exploration of the concepts taught in the Engineering course, equips them with further curiosity to try out their understanding and to learn more practically. The construct of abstract conceptualization in Kolb's Model, is similar to the DO construction, as both allow the students to interact with the educational content experientially. This helps students to refine their initial understanding and test the scope and limitation of the learned concepts. They are potentially also able to formulate and refine hypotheses regarding how the construct or the concept operates, which is what the 'DO' stage of the current model also intends to teach.

The proposed model uses a modified sequence based on two premises that make it more suitable than the sequence of stages used in Kolb's Model. The first premise is drawn from Dewey's Model that supports the active engagement of students with hands-on activities. As Dewey (1934) noted, "nothing takes root in mind when there is no balance between doing and receiving" (p. 45). Dewey's second stage specifically enables students to engage with the content in a manner that links it with their prior learning and past experiences. The second premise is drawn from Lewin's approach, which advocates an action research stance – where the learning is supposed to be cyclic, and the reflection stage forms a tentative pause (in the Lewin approach). As such, the proposed model intends to place 'reflection' at the third stage of a learning cycle, after the second, DO stage. The DO (second) stage of the proposed new model opens up space for also enabling the students to engage in activities that can link their current learning content with their past experiences, both from their past classroom learning experiences and their life learning experiences, as intended in Dewey's learning theory. Lewin's theory of learning also supports a stage where the learner has to engage in a process that explains life space based on new experiences that corroborate to the DO stage of the proposed new model. It is only through active engagement with the new learning that a person can assess his or her new reality (or rather assimilate new learning and new behavior).

The second stage in the model is therefore proposed as 'DO', and it is supported by the Principle of Inclusivity, as 'Doing' encourages all students to remain engaged at this stage. Students are actively enabled to experience learning by doing. It encourages the students to use the constructs in classroom activities through model development, and then to see the constructs applied in diverse settings, including hypothetical and practical contexts. The onus is on the instructors to facilitate these processes, and this highlights the utility of the Principle of Instructors' Professional Learning – which is expected to enable the instructors to do the job well. The instructors are also supported by the Model, as being aligned with the Principle of Structure and Specificity, the model has implications for the clear guidance and directions for instructors to follow at this stage. These implications for the instructors are discussed in a later section. The 'Doing' part of learning is essential for the students to absorb their lessons fully and to allow neural networks in their brains to develop around their new learnings (Kolb & Kolb, 2018). This also involves inspiring latent learning as by 'doing' students can learn new concepts and constructs at a more intimate level and make them part of their knowledge base (Zull, 2002). Research has found that 'doing' an activity encourages better retention of the memory, and creates what is called experiential memory which is long lasting and easily recallable (Kolb & Kolb, 2018; Zull, 2002). There is also evidence that 'doing' activities may involve the students in engaging more than just one sense, as opposed to passive observation of the instructor teaching and imparting knowledge which requires only the hearing sense (Kolb & Kolb, 2018). By engaging more senses, for example, the senses of touch, listening, smell along with the sense of sight, the students can potentially retain what they learn more holistically. Also, by carefully aligning the content with the Principle of Alignment with Industry needs, the Model ensures that the students' time is spent on learning content and gaining knowledge that applies to their future. Table 7.3 highlights the LBD practices and corresponding 21st Century Skills expected to be attained during this stage, and are reflective of adherence to the Alignment of LBD and 21st Century Skills.

Table 7.3

Stage 2 – DO: Related LBD Practices and C21st Skills

LBD Practices	C21st Skills
2. Discussions that are interactive and generate student contribution.	Creativity Communication Collaboration Team Work Critical Thinking, Cultural Sensitivity Ethical behavior, Life Skills Problem Solving Innovation Computer Literacy
3. Questions and answers that focus on the post-evaluation of learning activities are conducted in the sessions.	
6. Students are presented with problem-based questions where students, either in groups or as an individual, work out the solutions.	
9. Students do drills and practice as a means of learning and mastering a skill or a concept.	
16. Classroom activities encourage and motivate students.	

Figure 7.4 highlights the second stage of the proposed model as the DO Stage. The figure shows the alignment of this stage with the specific stages of three different theoretical models (those of Kolb, Lewin, and Dewey), with the principles. The figure also depicts the specific LBD practices and the 21st Century Skills that are to be the focus of this stage of teaching/learning (as mapped in Table 7.3).

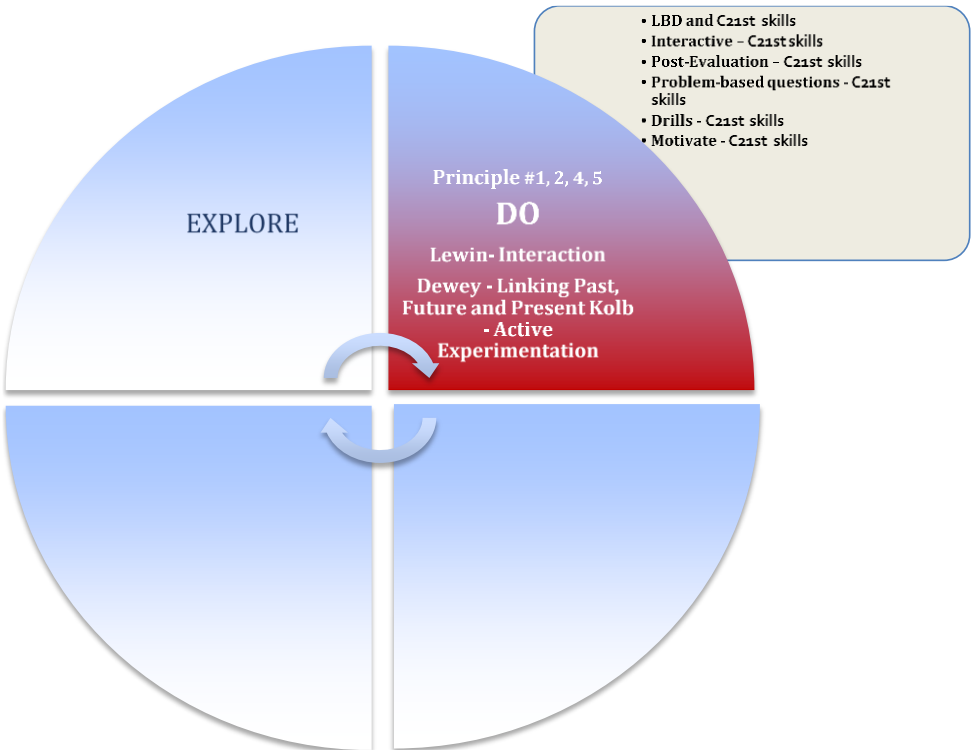


Figure 7.4. Stage 2 - DO Stage of the LBD Model

7.3.3. Stage 3 – REFLECT.

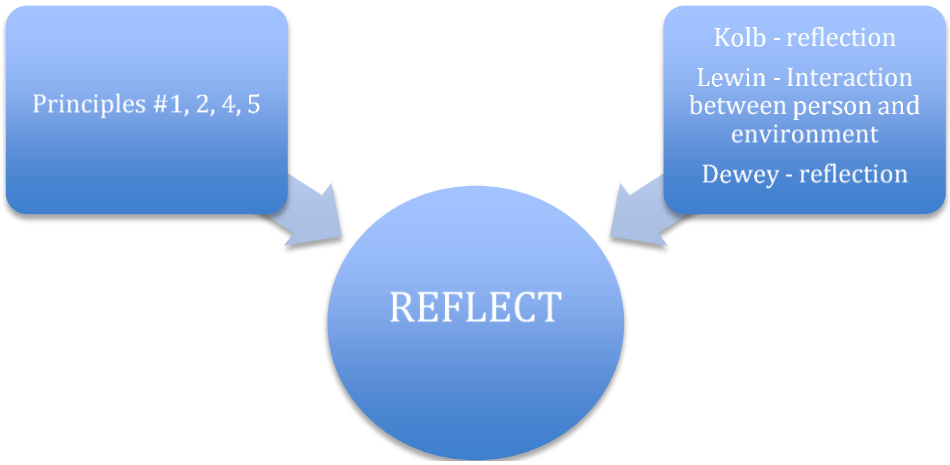


Figure 7.5. Stage 3 – REFLECT: Link with Principles and Theoretical Models

The third stage of the LBD model is to REFLECT. This stage is considered to be an essential part of the learning process by most of the leading theorists in the field.

Kolb (1984) encouraged learners to indulge in reflective observation as a means of immersing themselves in the experience and capturing the maximum learning from it. However, in the proposed new model, reflection is more accurately used as a stage where the learner actively evaluates learning, finds any gaps that still exist and maybe, is encouraged to seek out further exploration, thus setting the cycle in motion. Dewey's model also integrates reflection within the period of learning, and Lewin's force field dynamics, though not postulating reflection explicitly as a part of the learning process, does imply that thinking is needed for the growth of an individual. According to Lewin's theory of learning, changes in the perception of the environment or the relationship between the variables and concepts and constructs would invariably lead to changes in the learners' behavior or understanding, thus emphasizing the importance of reflection in the learning cycle of this model. In these three theoretical models, reflection is expected to be the endpoint or the point where one cycle of learning is considered to be complete. However, in the proposed new model, reflection is considered to also be a continuous process as students are required to keep notes and register their thoughts along the way while doing a more explicit and written analysis of their learning at the end of the process only.

The proposed new model is based on the assumption that reflection is an essential part of any teaching or learning activity to be undertaken by all students, as supported by the Principle of Inclusivity. Reflection is not just an activity that the students need to undertake at the end of their learning; instead, it is required before the students can apply their learning. While reflection is a distinct stage, it is possible and recommended by the proposed new model to build on reflection throughout all stages of learning. At each stage of learning, reflection is a possibility and needs to be encouraged. For example, the students, when they are exploring a construct, can engage in record-keeping and writing down their reflections. In the same manner, during the 'doing' stage, students might be encouraged to record their observations, thoughts, or even judgments about their learning.

REFLECT as a distinct stage is included in the proposed new model to ensure that there is a formal and explicit step requiring reflection in the learning process. The proposed new model ensures that all such reflection is geared toward creating deeper linkages between classroom learning and future industry needs that the students may need to display (thus adhering to the Principle of Alignment with Industry Needs). As in the case of the previous two stages, this stage is supported by the five Principles that were developed to guide the model. In particular, the reflection stage is supported by the Principle of Instructors' Professional Learning, as the instructors need professional learning to better help students to incorporate the skills and abilities of critical self-reflection. Also, the Principle of Structure and Specificity is apparent as the Model provides specific and targeted directions and outlines for the instructors to ensure they can conduct the classroom activities and assessments in a structured manner. Therefore, Stage 3of the model, as depicted in Table 7.4, ensures that the LBD practices and the corresponding 21st Century Skills are implemented (in keeping with the Principle of Alignment of LBD and 21st Century Skills).

Table 7.4

Stage 3 – REFLECT: Related LBD Practices and C21st Skills

LBD Practices	C21st Skills
10. Students are encouraged to reflect on what they have learned and express this reflection either orally or in written format.	Creativity Communication Collaboration Team Work Critical Thinking, Cultural Sensitivity Ethical behavior, Life Skills Problem Solving Innovation Computer Literacy
15. Instructors encourage students to record their impressions	

Figure 7.6 highlights the third stage of the proposed model as the REFLECT Stage, showing the alignment of this stage with the specific stages of the three different theoretical models, with the principles. The figure also depicts the specific LBD practices and the 21st Century Skills that are to be the focus of this stage of teaching/learning (as mapped in Table 7.4).

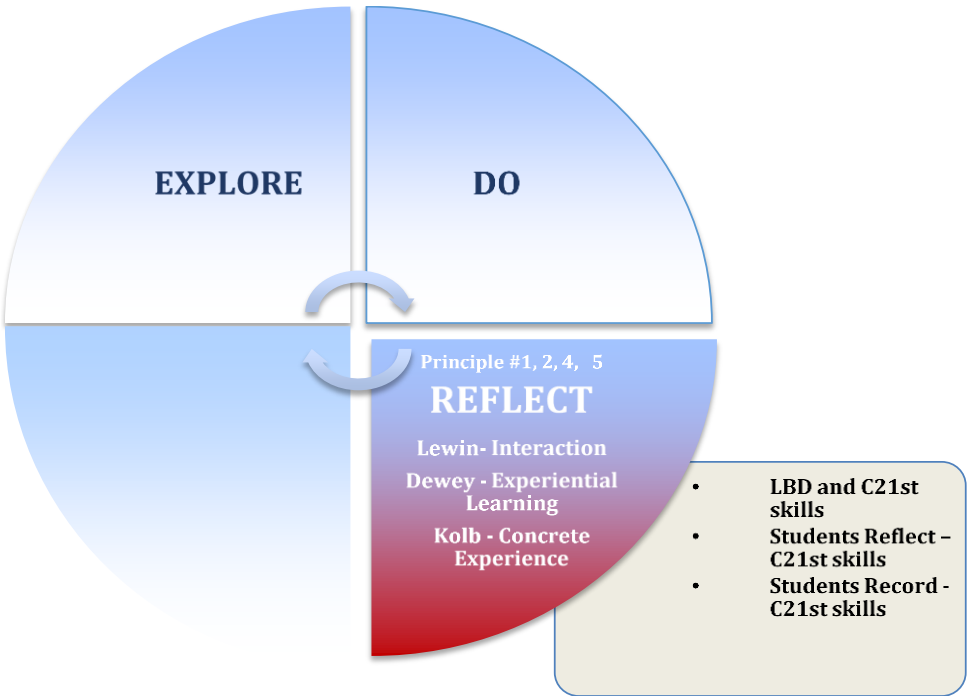


Figure 7.6. Stage 3 – REFLECT Stage of the LBD Model

7.3.4. Stage 4 – APPLY.

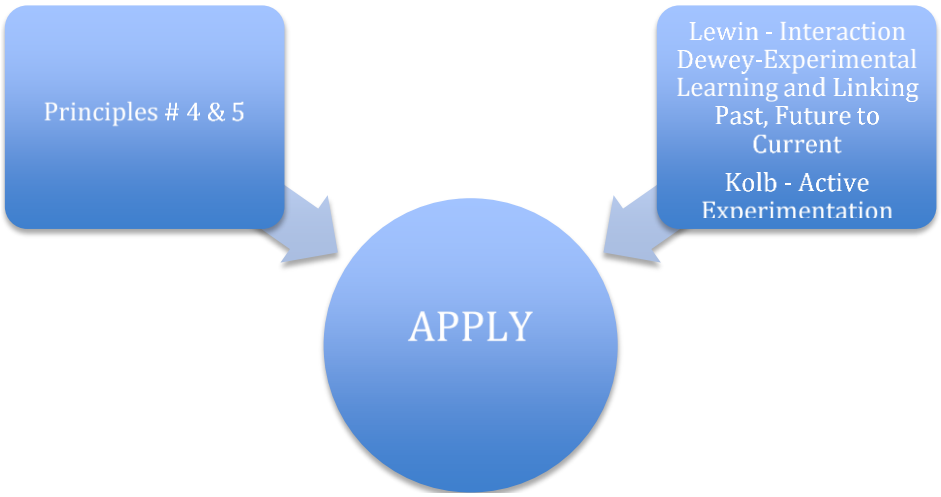


Figure 7.7. Stage 4 - APPLY: Link with Principles and Theoretical Models

The final stage of the model is APPLY, and its role is to make the process of learning (that was initiated using the EXPLORE stage and assimilated during the DO

stage, and consolidated with the REFLECT stage of the model) continuous and expansive. This stage potentially also enables the students to think in parallel constructions (where they can draw analogous solutions and apply their learning in different situations paralleling the situations and contexts in which they have learned), as well as in complementary ways (where they can try and apply their learning in novel ways, in situations different from the context for which they learned in class). More specifically, this stage encourages students to practice as well as apply what they experience and understood in class. This stage is more in concordance with Kolb's (1984) stage of 'Active Experimentation' where the learners are encouraged to use their learning in novel ways, test limits and arrive at their conclusions and further questions. While Dewey's Model (1938) does not have a specific stage corresponding to the APPLY stage, the underlying premise of his model lends support to the current stage as it is 'Application of the Learning' that is the desired aim of Dewey's Model. Dewey's Model also postulates an active engagement with learning content in a way that ensures that the new learning can be related to prior learning and can also be applied to future scenarios, thus emphasizing the continuity of learning or delineating learning as a continuous process. In the context of Lewin's Model (1977), this stage corresponds to the fact that the perceptual field is a dynamic space, and a person's perception and similar behavior in that field can be updated with learning. By exploring novel applications of learning, what is being encouraged is a shifting of the learner's perception of his/her field and the relationships between the variables – thus, leading to new learning. The fourth stage of the LBD model, therefore, ensures that the following LBD practices and their corresponding 21st Century Skills are learned (see Table 7.5).

This stage of the model emphasizes that the students should be able to apply what they learned in various conditions and situations and diverse real-life settings. Most textbook-based classroom teaching involves posing problems of a similar pattern to students and provides them with the repetitive practice for using formula and solving problems. The model endeavors to empower the students to comprehend and solve problems in their physical world and to make connections between their academic knowledge and their real work settings. Also, the ability to solve a variety of problems,

not just the ones that they learned in their classrooms is encouraged, and as such, the model is supported by the Principle of Alignment with Industry Needs. The instructors require the competencies and insights to enable and empower the students to apply their learning in a variety of situations as proposed by the Principle Instructors' Professional learning and the Principle of Structure and Specificity. In adherence to the Principle Alignment of LBD practices and 21st Century Skills, this stage of the Model maps out the following LBD practices with specific 21st Century Skills in Table 7.5.

Table 7.5

Stage 4 – APPLY: Related LBD Practices and C21st Skills

LBD Practices	C21st Skills
1. There are classroom activities that require students to collaborate and do teamwork	Creativity Communication Collaboration Team Work Critical Thinking, Cultural Sensitivity Ethical behavior, Life Skills Problem Solving Innovation Computer Literacy
4. Exam questions are focused on scenarios that require students to apply what they have learned and are not merely limited to ones that call for memorization, definitions	
6. Students are presented with problem-based questions where students, either in groups or as an individual, work out the solutions.	
11. In assessing a students' work, the instructor uses other means in addition to his/her assessment. This other means can be self-assessment or peer review.	
13. The college provides programs that bring students to the workplace as part of the students' preparation for professional working life after graduation.	

Figure 7.8 highlights the fourth stage of the proposed model as the APPLY Stage and builds on the previous Figures 7.2, 7.4, and 7.6 depicting the first three stages.

Similarly, Figure 7.8 shows the alignment of this stage with the specific steps of three theoretical models, with the principles. The figure also depicts the specific LBD practices and the 21st Century Skills that are to be the focus of this stage of teaching/learning (as mapped in Table 7.5).

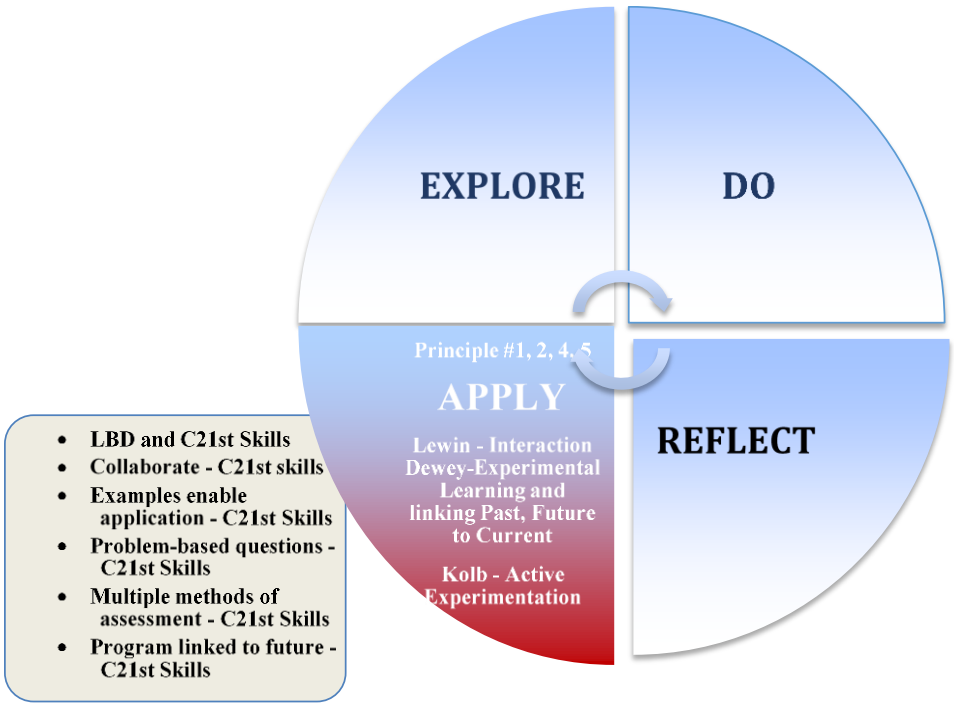


Figure 7.8. Stage 4 - APPLY Stage of the LBD Model

7.4. Proposed LBD Model

The previous section presented the evolution of the proposed LBD model using the five principles as the premise for development. The four stages are aligned with the theories of learning models of Lewin, Kolb, and Dewey. Figure 7.9 captures the proposed LBD model in totality and gives guidance for the development of teaching approaches and lesson plans based on the principles and stages discussed throughout this study. Figure 7.9 presents the specific aspects of each of the underpinning theoretical models that support the specific stage of the proposed new model. For example, the EXPLORE stage is underpinned by the five Principles and supported by the theoretical

propositions of Lewin's interaction, Dewey's experiential learning, and Kolb's Concrete Experience.

Further, the quadrant for EXPLORE is linked to reflect the specific LBD activities (5, 7, 8, 12, and 14) and their alignment with 21st Century Skills. From stage 1 EXPLORE, the next stage appears in the clockwise direction, as stage 2, DO. It also shows the theoretical link to Dewey's, Lewin's, and Kolb's theories of learning and how it can be used to align the 21st Century Skills and Learning-By-Doing practices. More specifically, it depicts the theoretical underpinnings of the stage DO, with Dewey's stage of linking past and future, Kolb's stage of active experimentation and Lewin's overall stage of interaction. It also shows the specific LBD activities that were found to be facilitating the DO stage, like activities 2, 6, 9, and 16 listed in Table 7.3.

In the same manner, the next stage of the model is shown as REFLECT, which is aligned with the stages of Kolb's concrete experience, Dewey's experiential learning and Lewin's interaction, and includes the LBD activities 10 and 15 as listed in Table 7.5.

The final stage of the proposed new model shows the APPLY stage and shows it as supported by Kolb's active experimentation, Dewey's experiential learning and linking past and future learning with current learning, and Lewin's interactive learning theoretical models. The LBD activities 1, 4, 6, 11 and 13 that are applicable during this stage are listed in Table 7.5

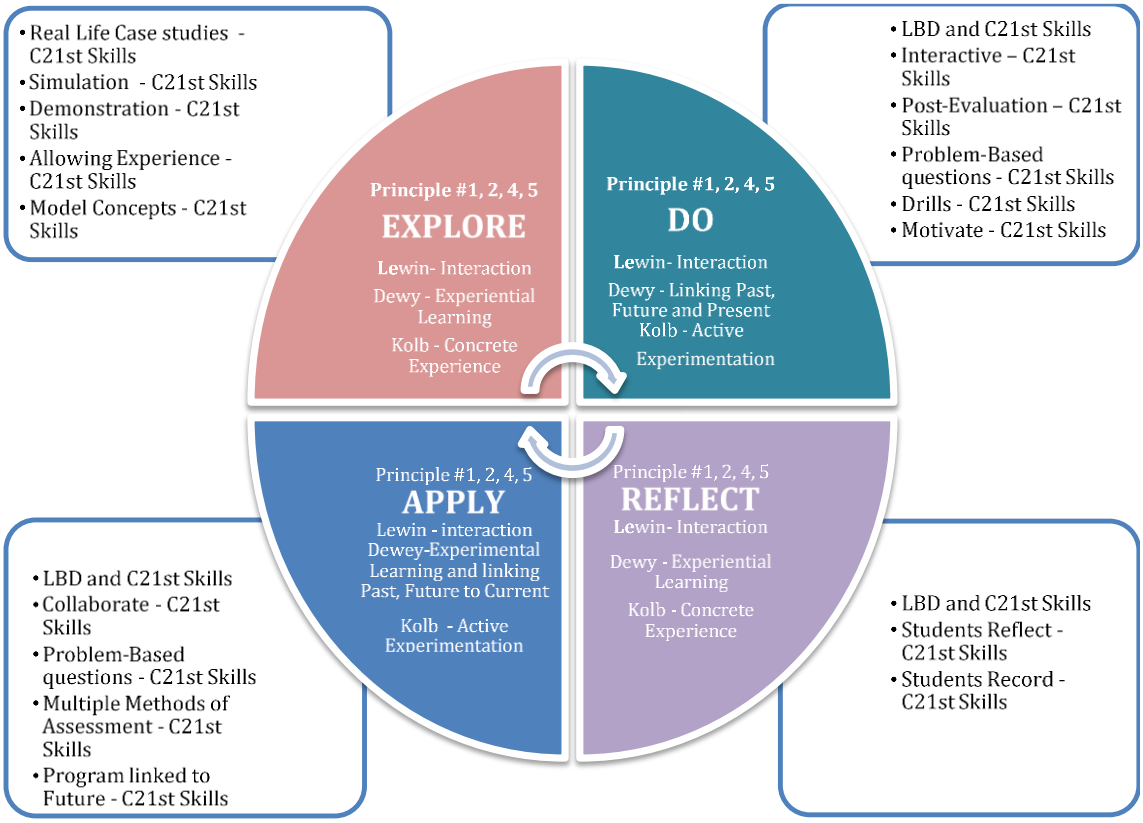


Figure 7.9. Proposed LBD Model

7.5. Implications for Implementation

Figure 7.9 provides the basic design or construction of the proposed new model. This section seeks to outline the implications for implementation of the model to be interpreted by the instructors, curriculum designers, students, and management of the target institute.

7.5.1. Implications for instructors.

It can be inferred from the findings that if it is to be successfully implemented, the proposed model needs to be supported by a change in the way instructors approach teaching as well as in their attitudes and mindsets. The proposed model supports a pedagogical model that at the time of data collection did not exist in the target institute. As such, the implementation of the proposed model would challenge the traditional way

of delivery currently practised. Instructors would need to move from the conventional linear approach of delivering the curriculum to a student-centered learning approach and holistic assessment within the framework of the LBD curriculum. Further, it is anticipated that the proposed model will inform the thinking of the instructors in the way they plan their lessons, assessment, and their approaches to delivering the learning objectives of the curriculum.

It is proposed that a Professional Learning Program, in line with principle 3, be developed to support the instructors both in understanding the concepts and applications of LBD and in terms of their lessons, assessments, attitudes, understandings and pedagogical approaches. Through professional learning, instructors would be able to develop a deeper understanding of the pedagogical approach that is involved in LBD curriculum implementation as well as have a deep-rooted understanding of the concept of 21st Century Skills. Another implication for instructors is that they would need to embrace a more collaborative and cooperative approach, working in partnership with the dean as well as with their colleagues to implement the proposed model.

7.5.2. Implications for curriculum.

Successful implementation of the proposed new model has implications for the Engineering curriculum of the target institute. There will be a need to review and develop policies and procedures that underpin the evolution of an Engineering Curriculum and instruction plan that could give a more comprehensive approach to both teaching delivery and assessment so that the students learn 21st Century Skills using the LBD practices. Also, there will be a need to create specific learning outcomes and supporting learning materials that are LBD aligned and 21st Century Skills cognizant. Another implication is for the development of detailed guidelines on effective planning of LBD practices and 21st Century Skills. More specifically, the curriculum would need to have an explicit assessment strategy that is LBD aligned and able to gauge students' learning of 21st Century Skills. It follows that the instructors need to have access to structured assessment materials that are LBD aligned and that aim to assess students on their acquisition of 21st Century Skills.

7.5.3. Implications for students.

The proposed model positions students at the center of the process of learning and aims to empower them in line with the recommendations of the LBD literature. As such, one implication for students is that they are provided with opportunities to express and test in *action* what they have learned and are not just going through the motions of class exercises. Additionally, it is proposed that by using the four-stage approach of the model, student reflections and thoughts become more connected with the outside world of experiences supported by the cyclic and applied nature of the new LBD model.

It is anticipated that through the implementation of the proposed new model, the students become more aware of 21st Century Skills and become active participants in the learning process. Additionally, as UAE industry requires graduates with the technical competencies and 21st Century Skills, the students will be better prepared to meet industry requirement.

7.5.4. Implications for management.

The proposed model involves several implications for management. Foremost, the management and leadership of the institute need to be involved in the process of implementation of the proposed new model by articulating the vision and communicating the change to the instructors. As well, the management would need to initiate and support the complete review of the existing curriculum, policies, and procedures and allocate the required resources in line with the higher mandate of the vice chancellor of the Institute for implementing LBD practices and 21st Century Skills.

Furthermore, the implementation is very likely to require management to provide funding and resources for professional learning opportunities to support instructors in terms of implementation. Academic managers might use the model to generate ways of evaluating and assessing the instructors' LBD practices implementation, with subsequent use as input for training needs analyses.

7.6. Teaching Around the New LBD Model

The holistic conceptual model is shown in Figure 7.11 as the Instructional Design Model for LBD implementation. This model captures the essence and complexity of development, as presented in the earlier sections of this chapter.

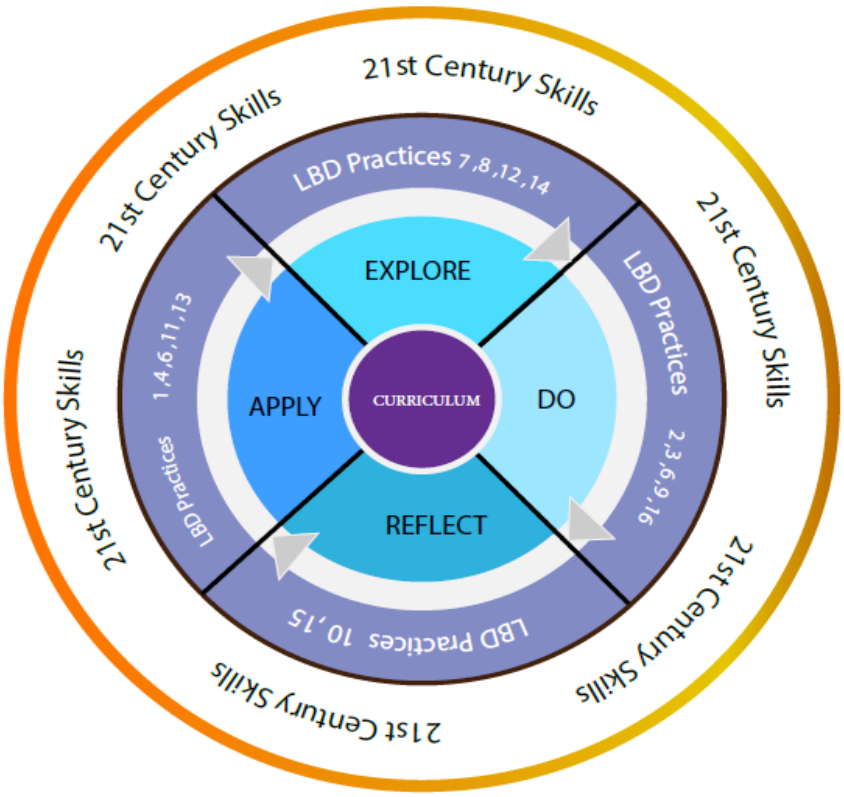


Figure 7.10. LBD Instructional Design Model

With the proposed instructional LBD model, it is possible for the instructors, curriculum developers, students, and management to have a better understanding of the concepts and constructs of LBD practices and 21st Century Skills, around which clear guidance and specific instructions about implementation and assessment might be developed, so that these practices and skills are learned inclusively by all of the students.

In summary, the instructors approach teaching by initiating the EXPLORE stage - posing a problem, then following the cyclic approach through the four stages to

address the challenge or issue at hand (refer again to Figure 7.11). In the EXPLORE stage, the instructors, therefore, are required to begin their topic by the introduction of a problem statement or by posing a challenge related to the topic. The problem that the instructors present at the outset calls for more exploration using LBD activities (5, 7, 8, 12, and 14). Instructors then enable exploration through real-life case studies, simulation, demonstrations, models, and other activities that thoroughly support students' experiences of the topic. Engaging in these activities aligned to the LBD practices, as seen in Figure 7.10, is expected to explicitly expose the significance of the 21st Century Skills as mapped by the proposed model.

The EXPLORE stage is followed by the DO stage, where the instructors facilitate students to become active and engaged with the content and topic at hand. This is accomplished through LBD practices such as asking students to answer problem-based questions and conducting drills and practices. These LBD practices are mapped to the 21st Century Skills in Figure 7.10.

The next stage of the model is REFLECT, which requires instructors to encourage students to pause and reflect on what they have learned and understood. This is facilitated by encouraging the students to engage in LBD practices (that are mapped with 21st Century Skills as in Figure 7.10). For instance, these activities might manifest through the keeping of journals or logs and recording what they did in their classes previously during the EXPLORE, and the DO stages. The instructors need to be skilled to enable students to conduct critical reflection using a reflection framework like Gibbs (1999) Cycle of Reflection.

Finally, in the APPLY stage, instructors need to focus on enhancing the students' abilities to apply their learning. This is done through LBD practices that are mapped with 21st Century Skills as in Figure 7.10 to encourage students to solve real-life application of problem-based questions, through multiple approaches to assessment and through exams that engage students to think of practical situations.

7.7. Limitations of the Study

The study was able to address the research questions and construct a new LBD model to enhance the teaching of the engineering curriculum at the target institute. However, there are several possible limitations to this study that have been considered and delimited in line with the focus of this study.

First, the study was limited in that it involved students and instructors from only one Engineering College within the United Arab Emirate. This group of participants were a convenient group who were most involved in the current pedagogical application of the LBD framework at the target institute. This study never intended to be generalizable to other contexts, but rather a response to the specific research question. It is hoped, however, that those in different settings may be able to find some value through comparison with their sites, and that some insights may emerge as they recognize aspects of this study that may apply in their circumstances.

Another possible limitation is that there might be some acknowledgment that this study did not analyze the existing documentation of the Engineering curriculum of the target institute. However, this data collection opportunity was not considered to be essential to this study. Instead, the focus was on the 'voices' of the participants that are the students, the dean, and the instructors, in pursuit of a response to how pedagogical approaches might be enhanced.

7.8. Recommendations for Future Research

There are specific recommendations for future researchers and scholars who wish to build on or extend this study. The first four recommendations are related to the modifications in the study design, while the last one is related to the expansion of scope for research in the field of LBD. This thesis focuses on *What constructively aligned Learning-By-Doing (LBD) pedagogical model, incorporating 21st Century Skills, can be developed for enhancing the teaching of engineering at HCT, UAE?*

The current study underscored the limitation that students' understanding of each statement related to LBD practices or 21st Century Skills, was not gauged, which could have established a necessary ground for asking their perceptions on whether they were being taught or assessed on them. Instead, the survey instrument was administered with the implicit assumption that students know what is being asked of them. Future research is, therefore, recommended to include an element of data collection that can establish students' basic understanding of LBD and 21st Century Skills.

> ***Recommendation One****: Use of the survey instrument needs to be tested on content validity to ensure that students understand what is being asked.*

The current study was limited as it used a self-report approach, where the students reported their perceptions, and instructors provided their opinions and viewpoints. The research findings are, therefore, from the instructors and the students, and by definition, subjective. Future research could add more objectivity by conducting a document analysis using the existing curriculum and lesson plans used by the Institute. It is also suggested that classroom observation methodology could be employed, which might give researchers first-hand insight into how the instructors were implementing or assessing 21st Century Skills and conducting LBD practices. Additionally, observation-based research could yield more practical insights for suggesting any new LBD model.

> ***Recommendation Two****: Future research includes observation and document analysis, along with interviews and surveys.*

The current study employed a single case, which implies that the findings may apply to this one Engineering program, in one specific Institute. To overcome such a limitation, it is important that any similar study, with some methodological changes as mentioned in Recommendation Two, be conducted across different programs, and include more institutions across different geographical locations in the United Arab Emirates and beyond.

***Recommendation Three**: Future studies building on this study might do so using more courses, more fields of study, and more institutions across the Emirates.*

The current study had refrained from straying into the actual mapping of each 21st Century Skill with specific LBD activities, simply because it was felt that doing this is a task worthy of full-scale independent research. However, such a mapping might be worthwhile to lend greater clarity on LBD's utility and scope with regard to the integration of 21st Century Skills.

***Recommendation Four:** Future research focus on integrating LBD practices and 21st Century Skills and developing a specific LBD aligned framework for the implementation of each 21st Century Skill in the Engineering field.*

The new LBD model that was developed was rooted in theoretical knowledge as well as practical insights gained from the empirical research in the engineering discipline. The model, therefore, warrants further trialing across different contexts.

***Recommendation Five:** Research is undertaken to trial the proposed model in a different context.*

7.9. Reflection

My professional doctoral journey started seven years ago when I decided to enroll in the program with the University of Southern Queensland (USQ). Given the many commitments I was engaged in daily, it was not an easy decision to make. In many ways, the start of the doctorate program has been a step forward to participate in the exciting debate of the changing context of Higher Education on the global stage. Indeed, it is has been an exciting journey but with many tensions and contrasting roles that a doctoral student needs to cope with and adapt to in this expedition.

In pursuing doctoral study, I faced many challenges at work and home. I changed jobs, relocated to different emirates, and welcomed a new infant member to the

family. Thus, I needed all the support I could get from everyone to continue my journey. I needed to make adjustments in the relationships with family, friends, and work colleagues at an earlier stage of the program. Lee (2008) claims that with roles as a student, family maker, and professional practitioners, the journey could be a challenge and sometimes overwhelming. The ability to manage my time between the various personal commitments and professional commitments and finding the time to study for the doctoral study was not an easy task.

As the doctoral journey unfolded, I became more aware of the uncertainty and ambiguity of this long road with many trials and multiple identities. Indeed, this unknown territory makes a person reflect on personal and professional life with different and conflicting thoughts. I started to explore some challenges of professional doctoral learning to include the practice of what has been learned during this journey. The challenge of being both a student with research capabilities and skills and practitioner leader implementing what has been learned and studied in the doctorate program was becoming obvious in my daily practice.

Undertaking doctoral study requires one to possess certain interpersonal and professional skills and attributes so as to successfully take on the challenges that doctoral study imposes. Time management, critical thinking, communication, and research skills are some of the skills. I think the most essential skills and attributes that a doctoral student must possess is the ability to be a reflective learner and be able to manage time effectively; prioritizing duties in life, and having the skills, and the courage to integrate what they learned into practice. Given everything I have gone through during the study, it was essential for me to remain calm and not to be overwhelmed with the duties and responsibilities of family and work commitments.

Through the ‘sensemaking’ identity of being a student and professional practitioner, I started to explore and make sense of my emergent identity. I have realized how this new identity was going to influence my doctoral study and how this identity will be affected by personal and professional discoveries. Even, without fully

understanding the implications of entering the new territory, one needs to quickly adjust to the unique setting, and the new identity to cope with things.

Reflecting on the educational leadership aspect of my professional role, I see that my leadership and learning are always knotted together and that I am continually reflecting on my leadership practice since taking the first module of the doctoral program. Such a reflection in the work setting has been conceptualized as a useful reflection which has been linked to creativity. Indeed, both creativity and reflection were essential 21st Century Skills of my study and are crucial elements in professional development, and both are fundamental to human thoughts and consciousness (Dawson, 2003). Leadership, for me, is to be clearer about my assumptions, both privately and publicly.

The final topic to which a professional doctoral student needs to devote is a good deal of time to the aspect of critical thinking skills. According to Haskins (2006), to become a skillful critical thinker, one needs to adopt the attitude to challenge his own assumptions; avoid critical thinking difficulties, recognize and characterize arguments. Brookfield (1987) posits that critical thinking is a universal human characteristic. I surely agree with his point and state that critical thinking can be developed in every person. I would, however, argue that some cultures and societies like the ones in the Middle East do not allow critical thinking to develop as well as western culture. But nothing can stop us from challenging our situations and assumptions to develop our critical thinking skills. This issue is an area of my study that I aimed to put at the top of my list of priorities always to develop in myself, in the students I teach, and in the colleagues, with whom I work at my workplace.

Conducting this research was rooted in my ambition to develop a new model that might enable students to develop 21st Century Skills through LBD practices in a manner that empowers them to meet future challenges. With my strong background in education, I believed that the potential to make a positive contribution to the field, and selecting an Institute where I could conduct the research was a conscious choice.

Lastly, as Michael Erben (1998) states, “individual motivations and social influences have no easy demarcation” (p. 1). External influences always influence our identity. As a doctoral student, I was faced with specific challenges during my long journey in the program. Dealing with multiple identities, uncertainty, ambiguities, developing self-awareness, and self-reflection are some that the doctoral learner is positioned to face during the program of study. I posit that since education today is more thought-provoking than ever, leaders in the education field who are lacking the ability to reflect and adapt will be left behind in results and progress.

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Appendix A: Interview Questions

Semi-structured Interview Guide for Engineering Faculty

The following should be done before the interview:

1. Consent forms should be explained and duly signed by the participant.
2. Copies of questions will be sent to participants before the scheduled interview.
3. Logistics for the focus group discussion should be prepared beforehand. These include the following:
    - Pencils and pads
    - Recording device
    - Room with projector
    - Slide Presentation/Table of 21st Century Skills

Interview Flow

1. Introduction

    At the start of the interview, the researcher should emphasize the following:

    - Introduce himself and provide a brief background of the research.
    - Emphasize the purpose of the research which is to develop a model that will embody the 21st Century Skills and the Learning by doing principles.
    - Inform the participant that the proceedings will be taped and once again verify his/her permission to do so.
    - Assure the participant that information gathered will be treated with utmost confidentiality and no name will be associated with any answers given.
    - Inform the participant that he/she can refuse to answer if he/she is not comfortable.
    - Inform the participant that he/she can withdraw participation anytime.

2. Explanation of the process

    - Researcher will inform that participants on how long the interview will be (1 hour)
    - Researcher will provide a copy of the interview questions in case the participant did not bring the previously provided one.
    - Researcher will provide a table of 21st Century Skills.

3. Questions:

    1. How would you define Learning-By-doing? How do you understand it?

2. What LBD activities do you do or have done to teach the students? Which one do you think worked best? Why do you say it works?
3. How do you plan LBD activities? How do you go about assessing learning?
4. What issues/problems arise or may arise in implementing LBD activities in HCT?
5. In your personal assessment, what needs to be done in order to sustain the LBD implementation in HCT?
6. Given the list of 21st Century Skills, which skills do you think the students acquire through your specific LBD activities? Which skills do you assess? How do you go about assessing these skills? Which of these skills are planned? Which of these skills are not planned but are manifested in your activities, teaching methodology and assessment?

Probes for Discussion

- Different implementations and concrete manifestation of LBD practices in the classroom.
- LBD related to Learning outcomes
- LBD related to activities and pedagogy
- LBD related to Assessment
- Problems or issues current or future
- Concrete suggestions of implementation
- Mention of 21st Century Skills intentionally being taught

Appendix B: Engineering Instructors Invitation Letter

March 2014

Dear Participant,

I am currently a student of University of Southern Queensland in Australia, taking up the degree of Doctor in Education. As part of the requirement of the program I am conducting a research entitled: Reengineering Engineering Education: Developing Constructively aligned Learning by Doing Pedagogical Model for 21st Century Education. As the title suggests, the overall aim of the research is a model that will embody the 21st century skills and the Learning by doing principles. This model is intended to help teachers and academic leaders in developing course outlines that are more attuned to your needs.

Part of the methodology is to conduct this interview to learn about your "Learning by Doing" practices and identify 21st century skills taught, learned, and assessed in the practice of "Learning by Doing" principles. The data gathered here will be used as input to the development of the model. As teachers, you are the developers of the learning strategies inside the classroom, hence you are indeed in the unique position to examine and analyze these elements.

The questions are divided into two aspects. You will be asked semi-structured questions about "Learning by Doing" in the first set and then 21st Century skills in the second set. Results will be presented in summary form and under no circumstances will your answers be singled out. You may also refuse to participate any time if you choose do so and even if you have already answered if you decide it is not in your best interest to participate, your data will be removed from the record. I will provide a consent form for your signature due the interview. Rest assured that your identity and data will be treated with utmost confidentiality and security.

Should you have any further questions about the research, please do not hesitate to email me at gfrache@hct.ac.ae or contact me at 050-6112507.

Very Truly Yours,

Ghassan Frache

Researcher

Appendix C: Consent

University of Southern Queensland

Consent Form for USQ Research Project Questionnaire

Project Details

Title of Project: Developing a Constructively aligned Learning by Doing Pedagogical Model for 21st Century Education at HCT, UAE

Human Research Ethics Approval Number: HXXREAXXX

Research Team Contact Details

Principal Investigator Details

Mr Ghassan Frache
Email: Gfrache@hct.ac.ae
Telephone: 02 8943 810
Mobile: (917) 50611 2507

Other Investigator/Supervisor Details

Professor Joan Conway
Joan.Conway@usq.edu.au
07 4631 2350

Statement of Consent

By signing below, you are indicating that you:

- Have read and understood the information document regarding this project.
- Have had any questions answered to your satisfaction.
- Understand that if you have any additional questions you can contact the research team.
- Understand that you are free to withdraw at any time, without comment or penalty.
- Understand that you can contact the University of Southern Queensland Ethics Coordinator on (07) 4631 2690 or email ethics@usq.edu.au if you do have any concern or complaint about the ethical conduct of this project.
- Are over 18 years of age.
- Agree to participate in the project.

Participant Name	
Participant Signature	
Date	

Please return this sheet to a Research Team member prior to undertaking the questionnaire.

Appendix D: Authority Consent

MADINAT ZAYED & RUWAIS COLLEGES

23rd October 2014

TO WHOM IT MAY CONCERN

I herewith confirm that Mr. Ghassan Frache has the approval and full support of Madinat Zayed & Ruwais Colleges Management and Staff to conduct the required research for his Doctoral thesis, "Developing a constructively aligned Learning by Doing Pedagogical Model for 21st Century Education at HCT, UAE".

This approval includes all elements of his research, both quantitative and qualitative.

Abdelaziz AlMheiri
Head - College Services
Madinat Zayed & Ruwais Colleges.

MADINAT ZAYED COLLEGES
P.O. Box 48848, Madinat Zayed, Abu Dhabi, UAE
Tel: +971 2 8943 700 Fax: +971 2 8940 681

RUWAIS COLLEGES
P.O. Box 12393, Ruwais, Abu Dhabi, UAE
Tel: +971 2 8943 800 Fax: +971 2 8778 158

Web: http://ruw.hct.ac.ae www.hct.ac.ae

Appendix E: LBD Survey Questions

Survey

Learning-By-Doing elements

دراسة

حول

عناصر التعلم بالممارسة

Researcher: Ghassan Frache

الباحث: غسان فراشة

RESEARCH INSTRUMENT

أداة البحث

Part 1: Questionnaire الجزء الأول : استبيان

Direction: Please assess the propensity of each statement based using the following scale:

توجيهات: يرجى تقييم كل بيان من البيانات في الأسفل باستخدام المقياس التالي:

Scale المقياس	Description الوصف	Interpretation التفسير
5	Always دائما	Being done 6 times in 6 situations. يتم إجراؤه 6 مرات من أصل 6 حالات.
4	Usually عادة	Being done 4 to 5 times in 6 situations يتم إجراؤه 4 إلى 5 مرات من أصل 6 حالات.
3	Occasionally أحيانا	Being done 2 to 3 times in 6 situations يتم إجراؤه مرتان إلى 3 مرات من أصل 6 حالات.
2	Almost Never تقريبا أبدا	Being done 1 time in 6 situations يتم إجراؤه مرة واحدة من أصل 6 حالات.
1	Never أبدا	Not being done at all لا يتم إجراؤه مطلقا

Statements البيانات	Rate				
	1	2	3	4	5
There are classroom activities that require students to collaborate and learn with and from each other. Examples are group projects that emphasize teamwork. هناك نشاطات في قاعة الدراسة تتطلب من الطلاب التعاون والتعلم مع وعن بعضهم بعضا. مثل على تلك النشاطات الجماعية التي تشجع العمل الجماعي.					
Discussions in the classroom are interactive meaning students as well as the teacher contribute to the topic being discussed. المناقشة في قاعة الدراسة هي وسيلة التواصل فالتعلم ليس فقط المتحدث الوحيد بل يسمح للجميع بالمشاركة ومناقشة موضوع الدرس.					
Question and answer that focus on post-evaluation of learning activities are conducted in the sessions. يتم في قاعة الدراسة طرح الأسئلة وذكر الإجابات التي تركز على التقييم اللاحق لتعلم النشاطات.					
Exam questions are focused on scenarios that require students to apply what they have learned and not merely limited to ones that call for memorization, definitions, etc. تركز أسئلة الإمتحان على السيناريوهات التي تحتاج من الطلاب تطبيق ما قد تعلموه وليس فقط السيناريوهات المبنية على الحفظ، التعريف، الخ					
The teacher uses real life case studies as a means for teaching the content of the course. يستخدم المعلم أمثلة لدراسة حالات من صميم الواقع كطريقة لشرح محتوى المادة.					
Students are presented with problem-based questions where students either in group or individual will work out the solutions. يتم طرح الأسئلة القائمة على حل المشكلات على الطلاب في قاعة الدراسة، حيث يقومون باستنباط الحلول فرديا أو جماعيا.					

Teacher uses simulation either digital or manual as a means of teaching a concept. يستخدم المعلم المحاكاة إما يدويا أو رقميا كوسيلة لتدريس مفهوم معين.					
Teacher demonstrates a required subject skill first then asks the student to follow suit. يوضح المعلم أولا المهارة الدراسية المطلوبة ثم يطلب من الطالب أن يحذو حذوه					
Students do drills and practice as a means to learning and mastering a skill or a concept. يقوم الطلاب بحل تمرينات وتدريبات كوسيلة لتعلم مفهوم او مهارة والتمكن فيها.					
Students are encouraged to reflect on what they have learned and express this reflection either orally or in written format. يتم تشجيع الطلاب على التفكير فيما تعلموه والتعبير عن الأفكار شفهيا أو كتابيا.					
In assessing student's work, the teacher uses other means in addition to his/her own assessment. This other means can be self-assessment or peer review. عند تقييم عمل الطالب يستخدم المعلم أو المعلمة طرقا أخرى مثل التقييم الذاتي للطالب أو المراجعة من زملائه					
Teachers conduct activities that allow students to fully experience the topic. Examples of these type activities are field trips and workshops. يقوم المعلمون النشاطات التي تسمح للطالب باختبار موضوع الدراسة بالكامل. مثال على هذا النوع من النشاطات الرحلات الميدانية وورشات العمل.					
The college provides programs that bring students to the workplace as part of the student's preparation for professional working life after graduation. تقوم الكلية بطرح برامج تجهيز الطلاب لسوق العمل كجزء من تحضيرهم للحياة المهنية بعد التخرج.					

Classroom activities that ask the students to model experiences or concepts are conducted. Examples of these type of activities are role-playing, reenactment or walkthrough (From process to output) يتم في قاعة الدراسة القيام بالنشاطات التي تحتاج من الطالب صياغة الخبرات والمفاهيم. مثال على هذا النوع من النشاطات لعب الأدوار ، وإعادة التمثيل أو العرض والتقديم.					
Teachers encourage students to record their impressions on how they made the project on a phase-by-phase basis. This requirement is in addition to the required output of the project. يشجع المعلمون الطلاب على تسجيل انطباعاتهم حول كيفية قيامهم بالمشروع على أساس المرحلة تلو المرحلة. ويعد هذا متطلبا إضافيا للمردود المطلوب من المشروع.					
Classroom activities are formulated in such a way that students can be more active and motivated in doing it. Examples of this type of activity are educational games and other hands-on means. تتم صياغة النشاطات في قاعة الدراسة بحيث يكون الطلاب أكثر نشاطا وتحفيزا في ممارستها. مثال على هذا النوع من النشاطات الألعاب التعليمية ووسائل الخبرة العملية.					

Part 2: Profile ... الجزء الثاني: معلومات شخصية

1) Gender النوع _____

2) Age العمر _____

3) College Campus الحرم الجامعي _____

4) Engineering Major التخصص _____

5) Year Level _____

Appendix F: 21st Century Skills Survey Questions

A Survey of 21th Century Skills
دراسة حول مهارات القرن الواحد والعشرين

Researcher: Ghassan Frache
الباحث : غسان فراشة

RESEARCH INSTRUMENT

أداة البحث

Questionnaireاستبيان

Directions: Please assess the frequency of each statement based on each skill within the context of whether it is taught or assessed in your classes using the following scale:

توجيهات: يرجى تقييم كل بيان من البيانات في الأسفل على أساس كل مهارة في السياق فيما إذا تم تعليمها، تعلُّمها أو تقييمها في القاعة الدراسية باستخدام المقياس التالي:

Scale المقياس	Description الوصف	Interpretation التفسير
5	Always دائما	Being done 6 times in 6 situations. يتم إجراءه 6 مرات في 6 حالات.
4	Usually عادة	Being done 4 to 5 times in 6 situations يتم إجراءه 4 إلى 5 مرات في 6 حالات.
3	Occasionally أحيانا	Being done 2 to 3 times in 6 situations يتم إجراءه مرتان إلى 3 مرات في 6 حالات.
2	Almost Never تقريبا أبدا	Being done 1 time in 6 situations يتم إجراءه مرة واحده ف 6 حالات.
1	Never أبدا	Not being done at all لا يتم إجراءه مطلقا

1. **Creativity**

1- الإبداع

	Taught تم تعليمه		Assessed تم تقييمه	
A	Teachers encourage me to come up with my own original thought rather than copying someone else's idea. يشجعني المعلمون على إظهار فكري الخاص بدلا من تطبيق فكره لشخص ما.	1 2 3 4 5	The teacher recognizes my original ideas in the classroom by giving me extra points or positive feedback. يميز المعلم أفكاري الخاصة في القاعة الدراسية عن طريق إعطائي نقاط إضافية أو تغذية راجعة إيجابية.	1 2 3 4 5
B	Teachers encourage me to contribute my own ideas in order to enrich an activity. يشجعني المعلمون على المساهمة بفكرتي الخاصة من أجل إثراء النشاط.	1 2 3 4 5	The teacher penalizes work that is copied and presented as my own work. يعاقب المعلم على الأعمال التي يتم نسخها وتقديمها على أنها من عمل الطالب نفسه أو الطالبة نفسها.	1 2 3 4 5
C	Teachers encourage me to express my ideas using multiple formats يشجعني المعلمون على التعبير عن أفكاري الخاصة بصيغ متعددة.	1 2 3 4 5	The teachers do not prescribe a uniform format in activities or evaluation rubric. لا يحدد المعلمون النشاطات بشكل واحد أو موحد عن طريق إزالة هذا التقييد من مبدأ التقييم.	1 2 3 4 5

2. Communication 2- التواصل

	Taught تم تعليمه		Assessed تم تقييمه	
A	Teachers encourage oral communication through activities that require presentation of ideas to others. يشجع المعلمون على التواصل الشفوي من خلال النشاطات التي تتطلب عرض الأفكار على الآخرين.	1 2 3 4 5	Oral presentation is part of grading rubrics in most of class activities. العرض الشفوي هو جزء من الدرجات في أغلب النشاطات الصفية.	1 2 3 4 5
B	Teachers conduct activities that require students to communicate within a group or team in order to fulfill a classroom tasks. يجري المعلمون النشاطات التي تتطلب من الطلاب التواصل ضمن مجموعة أو فريق من أجل استكمال الالتزام الدراسي في القاعة الدراسية.	1 2 3 4 5	Good communicators are rewarded through academic points and positive feedback. يتم مكافأة الطلاب اللذين يتواصلون بشكل جيد من خلال النقاط الأكاديمية والتغذية الراجعة الإيجابية.	1 2 3 4 5
C	Teachers encourage students to develop written communication skills through activities that require them to express their ideas in writing. يشجع المعلمون الطلاب على تطوير مهارات التواصل المكتوبة من خلال النشاطات التي تتطلب منهم التعبير عن أفكارهم بشكل مكتوب.	1 2 3 4 5	Essay questions are given in the exam and graded on contents and *expressed thoughts?*. ترد الأسئلة المقالية في الامتحان ولا تعطى درجاتها على محتواها فقط بل على الكيفية التي يعبر الطلاب فيها عن أفكارهم.	1 2 3 4 5

3. Collaboration 3- التعاون

	Taught تم تعليمه		Assessed تم تقييمه	
A	Teachers conduct classroom activities that encourage interaction among students. يجري المعلمون في القاعة الدراسية النشاطات التي تشجع التفاعل بين الطلاب.	1 2 3 4 5	Teachers include collaboration as one of the rubric guidelines for marking a classroom activity. يعتمد المعلمون على التعاون كدليل مبدئي من أجل إيجاد نشاط في قاعة الدراسة.	1 2 3 4 5
B	Open communication with a group or team members is emphasized by the teacher. يؤكد المعلم على جعل التواصل بين اعضاء المجموعة أو الفريق مفتوحا ويعتبره جزء من تقييم المشروع.	1 2 3 4 5	Teachers include team collaboration in project evaluation. يزود المعلمون المجموعات التي أظهرت تعاون ملحوظ بتغذية راجعة إيجابية.	1 2 3 4 5
C	Students are taught project management skills aside from the content of the project itself. يتم تعليم الطلاب المهارات اللائمة لإدارة المشروع في مسار منفصل عن تعليم محتوى المشروع نفسه.	1 2 3 4 5	Teachers grade each team member independently and as part of the team. يعطي المعلمون الدرجات لكل عضو فريق كفرد بحد ذاته أو كجزء في الفريق بشكل عام.	1 2 3 4 5

4. Teamwork 4- العمل الجماعي

	Taught تم تعليمه		Assessed تم تقييمه	
A	Teachers encourage teamwork through classroom activities that require students to work as a group. يشجع المعلمون العمل الجماعي من خلال النشاطات التي تتطلب من الطلاب العمل في مجموعات.	1 2 3 4 5	Teachers reward teamwork by including it in the rubrics of assessment. يكافيء المعلمون العمل الجماعي من خلال وضعه كأحد عناصر مبدأ التقييم.	1 2 3 4 5
B	Working as a team is emphasized. يتم التأكيد على العمل الجماعي ويعتمد كمبدأ في تقييم المشاريع.	1 2 3 4 5	Teachers provide individual ratings of team members in terms of their specific performance in the team project. يزود المعلمون تصنيف فردي لأعضاء الفريق بناءا على أداءهم المحدد في المشروع التابع للفريق.	1 2 3 4 5
C	Teachers teach students how to work as a team in order to succeed in classroom activities. يعلم المعلمون الطلاب على العمل الجماعي من أجل ان ينجحوا في النشاط داخل القاعة الدراسية.	1 2 3 4 5	Teachers provide post-project feedback on the strengths and weaknesses of the team. يزود المعلمون تغذية راجعة بعد انتهاء المشروع حول نقاط القوة والضعف عند الفريق.	1 2 3 4 5

5. Critical Thinking 5. التفكير الناقد

	Taught تم تعليمه		Assessed تم تقييمه	
A	Teachers provide activities where students use idea-generating techniques to develop several original ideas for product(s). يزود المعلمون بالنشاطات التي يستخدم فيها الطلاب تقنيات توليد الأفكار ليطوروا افكار أصليه متنوعة للمنتج/للمنتجات.	1 2 3 4 5	Teachers ask questions from different perspectives to elaborate and improve on the students' idea. يطرح المعلمون أسئلة جديدة، يتخذون وجهات نظر مختلفة ليعملوا ويطوروا على فكرة الطالب.	1 2 3 4 5
B	Teachers provide activities in which students are required to compare and contrast between two or three ideas. يزود المعلمون الطلاب بنشاطات تتطلب منهم المقارنة والمباينة بين فكرتين أو ثلاثة أفكار.	1 2 3 4 5	Teachers provide exam questions that require student to apply critical thinking. يزود المعلمون أسئلة اختبارات تتطلب من الطالب أن يطبق مبدأ التفكير الناقد.	1 2 3 4 5
C	Teachers provide activities in which students are required to examine the strengths and weaknesses of a concept. يزود المعلمون الطلاب بنشاطات تتطلب منهم اختبار مواطن القوة والضعف الخاصة بالمفهوم.	1 2 3 4 5	Teachers reward students opinions that may be different from others يحترم المعلمون رأي الطالب والذي قد يكون مختلف عن رأي الآخرين ويكافئونه.	1 2 3 4 5

6. Cultural Sensitivity 6. الحس
الثقافي

	Taught تم تعليمه		Assessed تم تقييمه	
A	Teachers conduct classroom activities that develop awareness of other cultures. يجري المعلمون في القاعة الدراسية النشاطات التي تطور الوعي حول الثقافات الأخرى.	1 2 3 4 5	Activities that celebrate cultural differences and awareness are conducted as part of the classroom or extra-curricular activities where student's participation is required. يتم إجراء النشاطات التي تحتفي بالإختلافات الثقافية كجزء من نشاطات قاعة الدراسة أو غيرها حيث يكون اشتراك الطالب فيها مطلوب.	1 2 3 4 5
B	Teachers explicitly encourage students to respect other cultures and beliefs. يشجع المعلمون بصورة صريحة الطلاب على احترام الثقافات والمعتقدات الأخرى.	1 2 3 4 5	Exam questions are developed to adjust to the cultural sensitivity of the learners. يتم تطوير اسئلة الاختبار لضبط التحسس الثقافي للمتعلمين.	1 2 3 4 5
C	College provides a forum where cultural differences are celebrated. تؤمن الكلية منتديات يحتفى بها بالإختلافات الثقافية.	1 2 3 4 5	Classroom activities that celebrate cultural awareness and sensitivity are part of the course plan. تعتبر نشاطات قاعة الدراسة التي تحتفل بالوعي والحس الثقافي جزء من الخطة الدراسية للمعلم.	1 2 3 4 5

7. Ethics 7- الأخلاق

	Taught تم تعليمه		Assessed تم تقييمه	
A	Teachers incorporate and emphasize ethical values in their classroom activities. Example of these values are honesty, punctuality, and respect يؤكد ويجسد المعلمون القيم الأخلاقية في نشاطاتهم في قاعة الدراسة. مثال على هذه القيم الصدق، الالتزام بالمواعيد، والاحترام.	1 2 3 4 5	Ethical principles such as honesty and punctuality have an effect on the grades either by awarding it or penalizing those who don't follow it. المبادئ الأخلاقية مثل الصدق والالتزام بالمواعيد لها تأثير على الدرجات إما عن طريق مكافأة من يتبعها او معاقبة أولئك الذين لا يتبعونها.	1 2 3 4 5
B	Teachers present and uphold a code of behavior as part of classroom management. يقدم ويدعم المعلمون قواعد للسلوك كجزء من إدارتهم لقاعة الدراسة.	1 2 3 4 5	Teachers provide positive feedback to students who have followed the code of ethics. يزود المعلمون الطلاب اللذين اتبعوا قواعد الأخلاق بتغذية راجعة إيجابية.	1 2 3 4 5
C	Teachers themselves serve as a paragon of ethical behavior in an effort to inculcate ethics to students. يخدم المعلمون بمثابة انفسهم نموذجا للسلوك الأخلاقي في جهد منهم لغرس الأخلاق في نفوس الطلاب.	1 2 3 4 5	Teachers are intolerant of unethical conduct and reflect this in how they grade students. لا يتساهل المعلمون مع الأداء غير الأخلاقي ويعكسون ذلك في كيفية منح الدرجات للطلاب.	1 2 3 4 5

8. Life Skills 8- المهارات الحياتية

	Taught تم تعليمه		Assessed تم تقييمه	
A	Teachers include self-reflection principles in classroom activities to encourage self-awareness يشمل المعلمون مبادئ التأمل الذاتي في نشاطات قاعة الدراسة لتشجيع الوعي الذاتي.	1 2 3 4 5	Teachers reward individual efforts in classroom activities. يكافيء المعلمون الطالب على جهده وقدرته على التكيف بالإضافة لتقديمه مشروعه في قاعة الدراسة.	1 2 3 4 5
B	Teachers teach not only intellectual knowledge but how to adapt to society by teaching skills use in personal and community life. لا يدرس المعلمون المعرفة الفكرية فقط بل كيفية التأقلم مع المجتمع وذلك بتدريس مهارات أخرى يمكن للطلاب استخدامها في حياتهم الخاصة والعامة.	1 2 3 4 5	Teachers consider students learning needs in the present and for the future. يتأمل المعلمون بحذر أولويات، كفاءات، تعلم، حاجات، اهتمامات، نقاط القوة وأهداف الطالب وذلك في الحاضر والمستقبل.	1 2 3 4 5
C	Teachers encourage students to see their own value in relation to themselves, their family and society as a whole. يشجع المعلمون الطلاب لكي يروا قيمتهم بالنسبة لأنفسهم ولعائلاتهم وبالنسبة للمجتمع ككل.	1 2 3 4 5	Teachers provide feedback not just on academic standing but on attitude adjustment. يعطي المعلمون تغذية راجعة ليس فقط على أساس أكاديمي بل على أساس تعديل الموقف.	1 2 3 4 5

9. Problem Solving 9- حل المشكلات

	Taught تم تعليمه		Assessed تم تقييمه	
A	Teachers provide classroom activities that encourage logical thinking and problem solving. يزود المعلمون في قاعة الدراسة بالنشاطات التي تشجع التفكير المنطقي وتطوير الحلول.	1 2 3 4 5	Teachers give grades based on students' ability to explain the advantages and disadvantages of Using innovative approach to present a particular topic or idea. يعطي المعلمون الدرجات بناءا على قدرة الطالب على شرح فوائد ومساوئ استخدام اوساط مختلفة لتقديم موضوع أو فكرة معينة.	1 2 3 4 5
B	Teachers conduct classroom activities that require students to examine different processes or paradigm and apply them to different types of problems يجري المعلمون في قاعة الدراسة نشاطات تتطلب من الطلاب اختبار عمليات مختلفة أو نموذج وتطبيقها على انواع مختلفة من المشكلات.	1 2 3 4 5	Projects that are research based are part of the assessment strategy. المشاريع المبنية على البحث هي جزء من استراتيجية التقييم.	1 2 3 4 5
C	Teachers conduct activities that require research in order to solve a problem. يجري المعلم نشاطات تتطلب بحث من أجل حل المشاكل.	1 2 3 4 5	Teachers award academic points to students who have provided good answers to problem solving exercises. يعطي المعلمون نقاط أكاديمية للطلاب اللذين زودوا بإجابات جيدة في تمارين حل المشكلات.	1 2 3 4 5

10. Innovation 10. الابتكار

	Taught تم تعليمه		Assessed تم تقييمة	
A	Teachers encourage me to develop my ideas and turn them into something practical. يشجعني المعلمون على أن أطور أفكاري وأحولها إلى شيء قابل للتطبيق.	1 2 3 4 5	The teacher use classroom activities that provide students the chance to create something new and innovative. يستخدم المعلم في قاعة الدراسة النشاطات التي تزود الطالب بالفرصة لخلق شيء جديد ومبتكر.	1 2 3 4 5
B	Teachers allow students a choice of criteria to be used to evaluate ideas, product prototypes or problem solution يسمح المعلمون للطلاب باختيار المعايير التي ستستخدم في تقييم الأفكار وانتاج النماذج أو حل المشكلات.	1 2 3 4 5	Teachers grade students' output based on justifications and evidence put forwarded by individual students. يقيم المعلمون انتاج الطالب بناءا على التبريرات والأدلة المقدمة من أي طالب.	1 2 3 4 5
C	The college provides ample resources in order to encourage me to transform my ideas into reality. تزود الكلية بمصادر وفيرة من أجل تشجيعي على تحويل فكرتي إلى حقيقة.	1 2 3 4 5	The teacher rewards work that has positive impact through academic points and positive feedback. يكافيء المعلمون الأعمال التي تترك أثرا إيجابيا كبيرا من خلال النقاط الأكاديمية أو التغذية الراجعة الإيجابية.	1 2 3 4 5

11. IT Literacy

	Taught		Assessed	
A	Teacher includes IT skills in teaching to support teaching and learning. يشمل المعلم مهارات تكنولوجيا المعلومات في تعليمه عن طريق توضيح كيفية القيام بها او يزود بطرق عن كيفية تعلمها.	1 2 3 4 5	The teacher requires deliverables to be made or developed using the IT skills learned by the students and include them as part of the assessment. (Examples: Reports done in word processors, Presentations done using presentation software) يطلب المعلم مواد للتسليم يتم إنجازها او تطويرها باستخدام مهارات تكنولوجيا المعلومات التي تم تعلمها من قبل الطلاب ويشملها كجزء من التقييم. (على سبيل المثال : تقارير تم إنجازها باستخدام برامج معالجة النصوص، عروض تقديمية تم انجازها باستخدام برامج العرض)	1 2 3 4 5
B	The college provides ample IT resources to help me in my studies. These IT resources include training and development. تزود الكلية موارد تكنولوجيا معلومات وافرة في قاعة الدراسة وفي الكلية ككل حتى تساعدني في دراستي. وتشمل موارد تكنولوجيا المعلومات هذه تطوير التدريب	1 2 3 4 5	Teachers provide positive feedback to students who are able to use their IT skills to produce good work. يزود المعلمون تغذية راجعة إيجابية للطلاب القادرين على استخدام مهاراتهم في تكنولوجيا المعلومات لإنتاج أعمال جيده.	1 2 3 4 5