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DESIGNING AND IMPLEMENTING THE UNDERGRADUATE CAPSTONE PROJECT IN THE INFORMATION TECHNOLOGY PROGRAM

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ABSTRACT

This study examines the design and implementation of a capstone project in an undergraduate Information Technology (IT) program at a public university in Malaysia. Using the 2018 Ornstein and Hunkins' curriculum approaches—content, process, and product—this research analyzes the perspectives of both faculty and students. Through semi-structured interviews, five key themes emerged: Articulation of Objectives, Roles, and Responsibilities (Curriculum Approach: Content); Continuation and Sequence (Curriculum Approach: Process); Integration of Theory and Practice (Curriculum Approach: Process); Responsibility of Learning (Curriculum Approach: Product); and Alignment of Technical Guidance and Supervision (Curriculum Approach: Product). The findings reveal significant gaps in course progression, a mismatch between students' skills and assigned projects, and unclear supervisor roles and responsibilities. These issues hinder students' ability to take responsibility for their learning and fully apply theoretical knowledge in practical settings. Recommendations are provided to improve curriculum design, clarify supervisory roles, and ensure better alignment of capstone projects with students' capabilities. This study contributes to the ongoing discourse on capstone project implementation, offering insights into how IT programs can better prepare students for the workforce.

Keywords: HIEPs, SoTL, capstone, curriculum approach, assessment, undergraduate education, computer education, information technology, Malaysia

Introduction

Next-generation learners need an environment that is flexible and adaptable. Such an environment will allow scientific, technologically enhanced, and professionally relevant methods of instruction to take place. Hence, 21st-century lessons require cutting-edge teaching embedded in a thorough and well-structured curriculum design (Ornstein & Hunkins, 2018). Nevertheless, the structures and formats of most course curriculums are most likely to be passed down from one generation of instructors to the next, seldom considering the underlying curriculum design principles (Doolittle & Siudzinski, 2010; Eberly et al., 2001; Fink, 2012) and relevance of the assessment plan. The reality of ongoing information and communication technology (ICT) changes calls upon researchers and practitioners to keep abreast with advancements. A well-designed capstone curriculum prepares graduates to apply the theories and skills accumulated throughout their three- or four-year undergraduate journey.

Capstone projects have long been considered a culmination of students' learning experiences, integrating theoretical knowledge with practical application (Stephen et al., 2002; Zhang et al., 2018). However, in Information Technology (IT), the increasing complexity of digital technologies demands a more focused curriculum design that bridges coursework and real-world problem-solving skills. While many studies have explored capstone design broadly, few have examined the challenges faced in IT-related disciplines, especially in a Malaysian context where technical skills and academic support are critical. This paper addresses this gap by examining the curriculum design of IT capstone projects through the lens of faculty and students. Moreover, discussing how the capstone project is tailored to the curriculum approach remains incomplete in the capstone literature.

Theoretical Framework

Scholarship of Teaching and Learning (SoTL)

The Scholarship of Teaching and Learning (SoTL) represents a systematic, evidence-based approach to investigating teaching practices and student learning outcomes to enhance educational quality across disciplines. SoTL operates on the principle that teaching, like research, benefits from reflective, inquiry-driven approaches and requires rigorous methodologies to explore the impact of pedagogical innovations (Boyer, 1990; Hutchings et al., 2011). By focusing on what works in teaching and learning, SoTL provides a platform for educators to improve their teaching and contribute to the broader understanding of effective educational practices through shared knowledge and peer review.

In the current study context, SoTL provides a relevant framework for understanding the design and implementation of capstone projects in undergraduate Information Technology (IT) programs. Capstone projects are recognized as one of the High-Impact Educational Practices (HIEPs) that engage students in deep learning, problem-solving, and practical application of theoretical knowledge (Kuh, 2008). However, the success of these projects hinges on how well they are integrated into the curriculum and how effectively students and faculty navigate the challenges involved in their execution. By examining both faculty and student experiences, this study aligns with SoTL's focus on improving teaching and learning through systematic inquiry.

This study contributes to SoTL in several ways. First, it provides insights into how curriculum design, particularly in a technical field like IT, can be optimized to support student autonomy and skill development. Second, it investigates the role of faculty and supervisors in facilitating student learning, which is central to SoTL's focus on the interplay between teaching strategies and student outcomes. Third, the study's findings on the integration of theory and practice in the capstone project speak directly to SoTL's commitment to exploring pedagogical approaches that prepare students for real-world challenges (Felten, 2013).

The application of SoTL in this study is particularly evident in the reflective analysis of the curriculum structure and the identification of key areas for improvement, such as clearer articulation of objectives, enhanced technical guidance, and better alignment of projects with students' skill sets. These findings are valuable not only for the specific IT program examined but also for contributing to broader discussions within SoTL about leveraging capstone experiences to foster deeper learning across various disciplines. SoTL emphasizes the importance of continuous reflection and evidence-based improvements in teaching and learning, particularly in enhancing student engagement and skill development. This approach also underscores the value of structured feedback and active stakeholder involvement in the educational process (Bukhari, 2021).

By situating the study within the SoTL framework, the research emphasizes the importance of continuous improvement in teaching practices, informed by the lived experiences of both educators and learners. This approach ensures that the capstone project, as an educational tool, remains relevant and effective in meeting the evolving demands of the IT industry while also promoting student engagement and success.

Ornstein and Hunkins' Curriculum Approaches

In this study, Ornstein and Hunkins' (2018) curriculum approaches of content, process, and product form the theoretical framework. This framework emphasizes how the curriculum should balance knowledge, practical skills, and professional readiness through three dimensions: the curriculum as content (what is taught), as process (how learning occurs), and as product (outcomes achieved). These principles were used to examine how the capstone project aligns with IT program objectives and the needs of both faculty and students.

Without the faculty and the students' perspectives, our concerns on the design and delivery of the capstone curriculum would not be empirically supported. Therefore, it is important to re-evaluate the capstone project for the IT discipline through the eyes of students and faculty and suggest improvements in the curriculum design and delivery. Specifically, we intend to seek answers to the following research questions: What are the issues in the curriculum design and delivery of the capstone project in the undergraduate-level IT program, and how do the capstone curriculum design approaches measure with the content, process, and product as delineated by Ornstein & Hunkins (2018)?

Literature Review

Capstone Project for the IT Program

A capstone project is one of the high-impact educational practices (HIEPs) for undergraduate students recommended by the American Association of Colleges and Universities (AAC&U). Typically conducted during the program's final year, it provides direct and authentic assessment in which students develop higher-order thinking skills and on-the-job performance. Significant 21st-century skills (Lai & Viering, 2012; World Economic Forum, 2020) such as communication, project management, decision-making, creativity, collaboration, critical thinking, and problem-solving converge well in the capstone literature (Hauhart & Grahe, 2015; McNamara et al., 2012; Schermer & Gray, 2012).

Graduates of IT are expected to not only have sound theoretical and conceptual knowledge of information and digital technologies (Malaysian Qualifications Agency (MQA), 2023, 2024) but also be adept in applying the knowledge to work projects successfully (Arora & Mittal, 2020). The curriculum design of the undergraduate IT program in the 21st century must include a plan to equip students with a capstone experience that allows them to use their knowledge and skills to manage projects and solve complex problems (Lesco, 2009; Lunt et al., 2008). Capstone projects, especially in the fields of IT and computer science, often require students to acquire new knowledge to complete the project effectively, and that too, in a highly compressed and limited timeframe (Perez et al., 2012).

Approaches of Curriculum in the Context of IT Program

In the early phases of curriculum design, curriculum developers should seriously consider how the course components are organized and interrelated. Ornstein and Hunkins (2014) explicate three ways of approaching curriculum: (1) curriculum as a content or body of knowledge, (2) curriculum approach as a process, and (3) curriculum as a product.

Curriculum as a Content

Curriculum developers emphasize topic outlines, subject matter, and concepts appropriate for the syllabus based on important criteria of content selection. Along with the selection criteria, several curriculum design dimensions (O'Neill, 2010; Ornstein & Hunkins, 2018) supposedly shape the conceptualization and design of a given curriculum. The six design dimensions, also known as BASICS principles, are (1) balance, (2) articulation, (3) scope, (4) integration, (5) continuity, and (6) sequence.

1. Balance. To establish balance in curriculum design, the assignment of content, time, experiences, learning outcomes, and other elements should be equal. When developing the content of the IT curriculum, there is a significant need to balance the discipline knowledge (i.e., subjects that use computing in substantive ways) with other, more generic skills (Lunt et al., 2008). The focus of higher educational institutions has been balancing the cognitive, affective, and psychomotor learning domains (MQA, 2024).
2. Articulation. Articulation can be constructed vertically or horizontally when designing the curriculum. In vertical articulation, the content fundamental for developing other crucial skills (Sacks & Barak, 2010) will be introduced earlier in the IT program as it is connected to establishing more advanced skills in the next semester. Lunt et al. (2008) propose that the Computing Platforms be taught in the second year of the program. Horizontal articulation entails courses to be taken at the same level/semester. In the integration-first approach, Lunt and colleagues (2008) suggest that two key courses, IT System and Web-System, should be presented together in a semester. Students should receive guidance on how they will progress through the program or transfer knowledge from one course to another (Kagawa, 2007).
3. Scope. To determine the scope of a curriculum, one must also consider the learners' time, diversity and maturity, complexity of content, and education level. The scope can be described using broad, limited, discipline-specific, simple, and generic terms. With a very wide scope of a curriculum, learners race through and have less opportunity to contrast, analyze, prioritize, and critique ideas (Clark & Linn, 2003). Consequently, learners tend to learn for the test through memorization and rote learning rather than conceptualization and application (Wright, 2011).

4. Integration. The curriculum should be multidisciplined, and subject matters or discipline content should not be isolated (Qing-bin, 2011). Integrative learning varies in several ways: "connecting skills and knowledge from multiple sources and experiences; applying theory to practice in various settings; utilizing diverse and even contradictory points of view; and understanding issues and positions contextually" (Huber and Hutchings, 2004, p. 13).
5. Continuity. Vertical repetition and recurring appearances of the content provide continuity. Learners have to develop and redevelop their ideas in a spiral (Bruner, 1960) fashion, which organizes the course/program into themes that require advanced depth as learners progress or "touches all the bases—experiencing, reflecting, thinking, and acting—in a recursive process that is responsive to the learning situation and what is being learned" (Kolb & Kolb, 2005, p. 194) through the course/program. Continuity can be incorporated in the content as well as in other skills such as teamwork, problem-solving, and writing skills.
6. Sequence. In designing a curriculum, the sequence is related to terms such as plan, process, and pre-requisite (see O'Neill et al. 2014). Contents and experiences are arranged in a sequence, i.e., in a hierarchical manner. The arrangement can be based on the logic of the subject matter or the developmental patterns of growth of the three learning domains. Lunt et al. (2008) propose the following sequence of courses: IT Fundamentals, Programming Fundamentals; Computing Platforms, IT Systems, Web Systems, Networking, Databases, Human-Computer Interaction, and Information Assurance and Security.

Curriculum as a Process

Curriculum as a process concerns the interaction between the instructor and learners. In capstone projects, the synergy between students and supervisors is crucial in determining the success of the projects (Pérez et al., 2012). Learning is geared toward being more learner-centered (Wright, 2011) as learners are demanded to be more critical and involved (Bukhari et al., 2021; Pisarik & Whelchel, 2018) in their academic journey. Weimer (2002) explicates the essentials of the learner-centered approach in terms of (1) the balance of power in the classroom, (2) the function of the course content, (3) the role of the instructor versus the role of the learner, (4) the responsibility of learning, and (5) the purpose and processes of evaluation.

1. The balance of power in the classroom. With learners as key stakeholders, it is necessary to balance the power between instructor and learners when determining the classroom policies and expectations, content and assessment, as well as the learning environment (Eberly et al., 2001). Forming a learning partnership (Magolda, 2005), instructors put together supports, challenges, and reflections to help learners develop complex frames of reference (Baxter et al., 2008) and a sense of autonomy that guide students' capstone endeavors and decisions (Pérez et al., 2012).
2. The function of the course content. This relates closely to the BASICS curriculum design principles. Meticulous design and selection of the content is crucial. Anderson and colleagues' (2010) findings suggest that students from the Computer Science and Engineering program must read sufficient literature and engage in practical projects for more meaningful learning experiences. Essentially, they learn learning strategies

and "keep alive" (Pérez et al., 2012) in their own intellectual development. As a result, learners become enthusiastic and engaged throughout the course/program (Anderson et al., 2010).

3. The role of the instructor versus the role of the learner. As the facilitator, the instructor helps learners clarify their understanding and assimilate the content meaningfully (McCabe & O'Connor, 2014). Learners become active seekers of knowledge who benefit when learning by doing as instructors provide considerable "technological mentoring" (Pérez et al., 2012). Activities that promote active engagement are crucial for learners in the IT program to relate ICT concepts and principles with applications in operational settings (Anderson et al., 2010; Lesko, 2009).
4. The responsibility of learning. As learners gain balanced autonomy, they are expected to remain committed to the policies and mutual expectations in the course agreement (Moxhama et al., 2013; Parkes & Harris, 2010; Pérez et al., 2012); self-regulation is the key (Lawanto & Febrian, 2016; Shah et al., 2019). The instructor plays an equal role and is responsible for designing expectations and content that trigger learners' curiosity. Such effort will produce mature and responsible learners who are continuously engaged throughout the course/program and motivated to probe deeper into the subject matter and related disciplines (Anderson et al., 2010).
5. The purpose and processes of assessment. According to Weimer (2002), assessment in a learner-centered classroom aims to provide grading and promote learning. With clear articulation of objectives and assessment plan (Dennis & Hall, 2007) and proper alignment to the objectives and teaching and learning activities (Biggs & Tang, 2011), assessment components can stimulate meaningful learning and reduce anxiety. Literature (Lesko, 2009; Rowe et al., 2011) has noted assessment practices—such as reflections, practical demonstration of newly developed skills, integration with other disciplines, and balancing conceptual learning and technological training—deemed crucial for graduates to be workforce-ready.

Curriculum as a Product

This is a set of defining documents that delineate what the entering and exiting student should be capable of (MQA 2023, 2024; North, 2007). The documents should describe the related areas to be experienced within the course and the intended results or outcomes of having experienced these activities. Curriculum guidelines for undergraduate degree programs in IT (Lunt et al., 2008) specify the core and advanced outcomes and the criteria that IT graduates should possess.

The Current Study

The Background of the IT Capstone Project

During their final year, students in the IT program at the School of Computing will need to complete a capstone project. This project is divided into two course-based projects: Project 1 and Project 2. The projects cover all topics in the program majors. Currently, there are five majors offered: (1) Software Engineering, (2) Networking, (3) Artificial Intelligence, (4) Applied Data Science, and (5) Information Management. At the beginning of semester 5, students enrolling in Project 1 must write a proposal to develop a system. The supervisor usually provides a specific topic/system. In Project 2, students must implement the ideas they proposed in Project 1. The skills required for system development are covered in all core courses. However, certain system developments, especially those that align with current trends, are only covered in the courses for Software Engineering and Networking majors. Most of the suggested projects may not always conform with core courses taken by students majoring in Applied Data Science. In the past, it has been observed that students, regardless of their majors, faced difficulties in Project 2, which is the actual development of the project.

Research Objectives and Questions

This study's research objectives are framed by the three curriculum approaches proposed by Ornstein and Hunkins (2018)—content, process, and product. The primary objective of this study is to investigate the design and implementation of the IT capstone project from the perspectives of both students and faculty members. Specifically, the study seeks to (1) Identify the challenges related to curriculum design and alignment in the IT capstone, (2) Explore the roles of faculty and supervisors in facilitating student success, and (3) Assess how effectively the capstone project integrates theoretical knowledge with practical application.

Methodology

This study adopts a collective case study approach (Stake, 1995), focusing on multiple perspectives from students and faculty within the IT program. The use of semi-structured interviews in focus group discussions allows for in-depth exploration of experiences and insights, suitable for understanding the complex dynamics of capstone projects in this context. In conducting the interviews through the focus groups, particular attention was given to informed consent and protecting the rights and interests of research participants, especially student participants. Measures were taken to ensure confidentiality and voluntary participation, following ethical guidelines.

The research objectives of this study are grounded in the three curriculum approaches proposed by Ornstein and Hunkins (2018): content, process, and product. These approaches provide a comprehensive framework for understanding how the IT capstone project is designed and delivered. The primary objective of this study is to investigate the capstone project from the perspectives of both students and faculty members. Specifically, the study aims to (1) Identify issues in the curriculum design of the capstone project in the undergraduate-level IT program, (2) Identify the issues in the curriculum delivery of IT capstone, and (3) Identify the outcomes of the IT capstone curriculum.

The research model is structured through a mapping process that links the curriculum approaches to the research questions and the interview guide. This mapping ensures that the questions posed during the interviews are directly aligned with the curriculum framework, allowing for a focused and systematic exploration of the key elements of content, process, and product. Table 1 provides a detailed representation of this mapping, showing how each curriculum approach is connected to specific research questions and the corresponding elements in the interview guide.

Table 1: The Research Model

Curriculum Approaches	Research Questions	Interview Guide
Curriculum as a Content (1) Balance, (2) Articulation, (3) Scope,	What are the issues in the curriculum design of the capstone project in the	How do you perceive the efficiency of the current capstone project in integrating theoretical

Curriculum Approaches	Research Questions	Interview Guide
(4) Integration, (5) Continuity, and (6) Sequence.	undergraduate-level IT program? How do the capstone curriculum design approaches measure the content?	knowledge gained through coursework into practical application?
Curriculum as a Process (1) The balance of power in the classroom, (2) The function of the course content, (3) The role of the instructor versus the role of the learner, (4) The responsibility of learning, and (5) The purpose and processes of evaluation.	What are the issues in the curriculum delivery of the capstone project in the undergraduate-level IT program? How do the capstone curriculum design approaches measure the process?	Does the capstone project prepare the students for real professional life challenges? Why or why not?
Curriculum as a Product Intended outcomes when exiting the course	What are the outcomes of the IT capstone project? How do the capstone curriculum design approaches measure the product?	What skills would the IT graduates possess at the end of the program?

Participants

Eight faculty members and eight final-year undergraduate students participated in this study. The participants provided their thoughts and experiences in semi-structured interviews and focus group discussions. The faculty members consisted of lecturers teaching two sequential applied courses (Project 1 and Project 2—termed the Capstone project) and the supervisors responsible for endorsing and supervising students' projects. Purposive sampling, while limiting sample size, was chosen to ensure that participants with direct experience supervising and completing capstone projects were included. The faculty members, four females and four males, had at least three years of experience supervising capstone projects in their department, apart from teaching regular computer science courses. Student participants, four females, and four males, were recent graduates who completed their capstone projects the previous semester. The characteristics of all participants are summarized in Table 2.

Table 2: The Demographics of Participants

No.	Pseudonym	Gender	Role	Background	Qualifications
P1	Lecturer DA	Male	Lecturer	Applied Data Science	Ph.D.
P2	Faculty Member DN	Female	Both	Information Management	Ph.D.
P3	Supervisor L	Female	Supervisor	Software Engineering	Ph.D.
P4	Supervisor AH	Male	Supervisor	Software Engineering	Pursuing Ph.D.
P5	Lecturer H	Female	Lecturer	Information Management	Ph.D.
P6	Faculty Member Y	Female	Both	Artificial Intelligent	Ph.D.
P7	Supervisor DS	Male	Supervisor	Networking	Ph.D.
P8	Faculty Member DK	Male	Both	Information Management	Ph.D.
P9	Student W	Female	Alumnus	Software Engineering	Matriculation

No.	Pseudonym	Gender	Role	Background	Qualifications
P10	Student H	Male	Alumnus	Information Management	STPM
P11	Student Na	Female	Alumnus	Applied Data Science	STAM
P12	Student N	Male	Alumnus	Networking	STPM
P13	Student K	Male	Alumnus	Information Management	Matriculation
P14	Student ZK	Female	Alumnus	Information Management	STAM
P15	Student AF	Male	Alumnus	Artificial Intelligence	Diploma
P16	Student NR	Female	Alumnus	Software Engineering	Diploma

*Note. P: participant; STPM: *Sijil Tinggi Persekolahan Malaysia* [Malaysian Higher School Certificate]; STAM: *Sijil Tinggi Agama Malaysia* [Malaysian Religious Higher School Certificate]

Data Analysis

We employed thematic analysis (Braun & Clarke, 2013), which involved three steps: (1) multiple reading of the transcripts, (2) coding, and (3) categorizing them into themes. Initial codes were built from the data through multiple transcript readings. Once the initial codes were created, we individually looked at the evolving themes from the initial codes, compared our analysis, and agreed upon those with common features and patterns. Five primary themes were finalized after the participants refined the data through member-checking discussions. The themes were mapped based on Ornstein and Hunkins' (2014) curriculum design approaches: content, process, and product.

In addition to interviews, observational field notes were used to cross-validate findings. Data from faculty and students were analyzed separately to account for their differing roles. Faculty data highlighted concerns about curriculum continuity and supervision, while student data emphasized the challenges of integrating theory and practice, particularly regarding technical guidance.

Although data from faculty and students were analyzed separately to account for their distinct roles in the capstone project, eventually mixing the data was driven by recognizing that both perspectives contribute to a fuller understanding of the program's strengths and challenges. Faculty provided valuable insights into curriculum design, supervision, and the continuity of learning objectives, while students highlighted the practical application of theoretical knowledge and the technical support needed for success.

By integrating faculty and students' complementary viewpoints, we could identify overlapping themes—such as the alignment of objectives with practical skills and the need for clearer guidance—that may not have emerged as strongly if the data were kept separate. This holistic approach aligns with SoTL's focus on reflective analysis and continuous improvement in teaching and learning, as it recognizes the interconnectedness of the experiences of both educators and learners. Furthermore, it emphasizes the importance of including multiple stakeholders to ensure a more comprehensive and actionable assessment (Bukhari, 2021). Therefore, combining the faculty and student data provided deeper insights and strengthened the validity of the themes that emerged.

Results

In this study, we aimed to investigate the issues in the capstone project for an undergraduate-level IT program offered by the School of Computing. On analysis, we found five primary themes. We also map the themes in the context of the curriculum design approaches by Ornstein and Hunkins (2014), which were discussed earlier. What follows is the elaboration of the findings with selected evidence from the participants' transcripts.

Theme 1. Articulation of the Objectives, Roles, and Responsibilities (Curriculum Approach: Content)

The articulation of clear objectives is crucial to the content approach. Several supervisors and students discussed the lack of clarity in the project objectives, which affects students' ability to deliver. Several supervisors noted that the scope is very broad, and the time is very limited, making it hard for students to manage their projects effectively. Also, articulation is not limited to articulating the subjects offered but includes delineating clear roles and responsibilities between the lecturer and the supervisor. The ambiguous roles between the supervisor and the lecturer have confused the project's supervision. There was no predefined role for lecturers teaching the theory and supervisors overseeing students' projects.

I am not quite clear about the roles of a supervisor ... if the students are required to build mobile applications and do not have prior experience [to do that] ... do I need to teach [them]? Fortunately, I am teaching mobile programming, so they can just enroll in my class… so they can learn that or to do that ... but still, what [are my] roles?

Supervisor AH

One of the students revealed her dilemma,

[t] The communication with my supervisor was very bad…. When I messaged him [the supervisor], he replied that I should see my lecturer. When I contacted my lecturer, he told me he did not want to be involved, that my supervisor should handle it, and that I should see my supervisor.

Student Na

Some lecturers argued that supervisors need to be more proactive, as students tended to consult the lecturers more than their supervisors. More confusion occurred when the supervisor was also referred to as a client. This gave most supervisors the presumption that they had the privilege to demand that students conduct projects based on their desires. A supervisor expressed his concerns when some supervisors literally adopted the client role in their capstone supervision.

…the term client; I do believe… is very misleading. When you are defining your supervisor [as] a client… you tell what you want but [not] necessarily, you guide the students in how to get it done… by hook or crook, [students] do whatever it takes to build an application…

Supervisor AH

Theme 2. Continuation and Sequence (Curriculum Approach: Process)

This theme aligns with the process approach, focusing on how learning experiences are sequenced throughout the capstone project. Faculty expressed concerns about the need for a clear and logical progression from theoretical learning to practical implementation, which is critical for student success in the capstone.

Students in the School of Computing come from diverse educational backgrounds, having entered the program through one of four qualifications: (1) a matriculation certificate from the Ministry of Education, Malaysia, (2) at least three principal passes in the Sijil Tinggi Persekolahan Malaysia (STPM), which is Malaysia's higher school certification, (3) a diploma from a recognized institution in Malaysia, or (4) a high school pass certificate from the Malaysian religious stream, known as Sijil Tinggi Agama Malaysia (STAM). As a result, students begin the IT program with varying levels of academic preparation and prior exposure to IT-related subjects.

Faculty members observed that students with matriculation or diploma qualifications often had an advantage, as many were exposed to critical subjects such as Additional Mathematics and ICT-related courses before entering the program. This prior exposure better prepared them for the challenges of the capstone project. As Lecturer DA explained,

... if the student has a diploma... they will excel a little bit when it comes to projects. They were trained to work on projects before they joined us... For the students ... from the matriculation... their ability [differed from other students], maybe they have already learned a small quantity of advanced math and programming before that so maybe there is a small number of advantages to them compared to those who came into the program with STAM.

Lecturer DA

However, there is a noted disconnect between earlier courses and what is required in the capstone, particularly in Project 1 and Project 2. According to Supervisor AH, students often struggle to connect their previous knowledge to the capstone project tasks, especially in technical areas like mobile programming.

Students often struggle to connect previous knowledge with the capstone project tasks as they need to relearn everything in courses like mobile programming...

Supervisor AH

indicating a lack of sequence between courses leading up to the capstone.

Students echoed these concerns, emphasizing the gaps they experienced between different phases of the capstone. These gaps impacted their ability to synthesize knowledge and skills acquired throughout their academic journey, further highlighting the need for a more structured and well-sequenced curriculum that better prepares students for the complexities of the capstone project.

Theme 3. Integration of Theory and Practice (Curriculum Approach: Process)

This theme is best understood through the process approach, which centers on how students apply theoretical knowledge in practical contexts. In addition to concerns about the continuity and sequencing of courses, faculty members pointed out issues related to the disintegration of course content. They felt that if the courses were more cohesively integrated, students would be better able to reinforce their knowledge, understanding, and skills in IT through exposure to varied sources and task-based assessments. However, students often did not see the connections between different skill sets, as lecturers did not adequately demonstrate how these skills interrelate.

One lecturer, Lecturer H, expressed concern over students' lack of readiness when tasked with developing a mobile application, noting that this was due to fragmented learning experiences,

… we work in silo… when [students need to develop] mobile application, they could not synthesize what they have learned… I need to teach them [again] database, … the back-end services, and also front-end… … they could not do GUI even though they have already taken the subjects… Because when developing a mobile application [they] have to request database, [they] need to build [their] own [application programming interface] API, that API needed to be built using [personal home page] PHP tools, Python or whatnot but, they cannot see how that can be done…

Lecturer H

This statement underscores the difficulties students face in connecting disparate pieces of knowledge from their coursework. The isolated teaching of subjects like database management, API development, and front-end design leaves students ill-equipped to understand how these components fit together in a real-world project. This lack of integration in the learning process prevents students from developing a holistic understanding of application development, ultimately hindering their ability to apply theoretical concepts in practice.

Theme 4. The Responsibility of Learning (Curriculum Approach: Product)

This theme is closely tied to the product approach, which emphasizes learning outcomes and the development of student competencies. Both faculty and students acknowledged that cultivating independent learning skills is a key expected outcome of the capstone project. However, students reported that insufficient technical guidance often hindered their ability to take ownership of the learning process fully.

In addition to technical challenges, findings revealed that many students lacked the critical non-technical skills necessary to complete their projects. These included essential skills such as self-regulation, critical thinking, and problem-solving. The absence of these skills contributed to many students struggling to finish their capstone projects successfully. Faculty members observed this gap, noting that students often had difficulty managing their time and resources effectively, which are crucial for independent project work.

As one faculty member remarked,

…soft skills are important, which many students do not have. The right attitude for learning, persistence, and problem-solving are required to do these projects. If they try, they can get many resources to teach them, such as programming, but they do not want to do it independently.

Faculty Member DN

In addition to students' ability to integrate the knowledge and subjects they have learned in meaningful ways, they must be able to communicate their work and findings in writing. One of the supervisors noticed the lack of writing skills among her students in her supervision.

… [the students] are not good at writing; they felt that writing a proposal is challenging. When they took the research method class, they did the proposal in groups, but they did it individually when they wrote for their projects.

Supervisor L

As the projects started, lecturers provided briefings during the first class. Since this was conducted separately for each group taking the project in that particular semester, it is understandable that the process lacks standardization. Furthermore, students felt that the briefings did not qualify as orientation as they were inadequate. One student stated,

[for] briefings of Project 1 [and] Project 2, there are various types [of briefings] that are not that comprehensive.

Student W

We asked the students for suggestions on how the department could better assist them during the orientation. One student proposed that the orientation include a hands-on workshop to help them revise the skills they need.

First, I will have a workshop where I start on [things we learned earlier] ... not on documentation, but website development. ... even [in] the workshop I [attended], it was not [focusing on how to start] but ... roughly on the outline [of the project] ...And one day is not enough, sir, maybe two days… Something [that the students] will get.

Student H

Theme 5. Alignment of Technical Guidance and Supervision (Curriculum Approach: Product)

Technical guidance is essential for students to produce high-quality capstone work as part of the product approach. Both groups highlighted the need for more direct technical support, with faculty acknowledging the difficulty in providing hands-on supervision due to time constraints and limited resources.

Moreover, students reported a significant mismatch between their skills and the projects assigned to them. The findings revealed that many students reported that the assignment of topics for the capstone project needed to be reconsidered. Projects were assigned on a first-come-first-served basis; hence, the students who registered first got the projects of their liking, while students who got to choose later often ended up getting projects that they did not like or the ones that required skills they did not possess. One of the students reported being assigned a web development project while he was a Networking major. He claimed,

I am a Network[ing] major, but when I chose my project, there were no suitable projects available. So, I chose web development, but it was not easy since I lacked the technical skills needed.

Student N

Only three students interviewed reported getting projects from their field or at least some aspects of their project that were within the area of their specialization.

On the other hand, there were also instances where students were assigned a supervisor who was not an expert in the technology required to carry out the projects. This led to the students not getting suitable technical guidance to carry out their projects properly. For example, a student was assigned a project that required programming skills. However, the supervisor was not from the programming field. One of the students explained,

[W] When I tried to discuss my problems with my supervisor, he would say, "I am sorry, I am not quite familiar with this since I am not into programming." I had to take the help of online tutorials…

Student K

In some cases, supervisors, regardless of background and expertise, tended to request students concentrate their capstone projects on system development based on current trends such as mobile programming and the Internet of Things (IoT). This has been proven problematic as some of the skills required to develop them were covered in certain majors in the program but not in other majors.

Sometimes, supervisors are also influenced by the trends in technology. Whatever technology comes, people just twist their interests into it [without considering] students' skills, exposure, and the feasibility of achieving the intended goal.

Faculty Member Y

One of the supervisors embeds classroom empathy in his suggestions as he considered students' interests, continuous development of student skills, knowledge, effort, and early mentoring.

... have just one project for students to complete… project that they are interested in [based on] whatever subjects they have taken. [The project that] they have put effort into ... in developing one application.

Supervisor AH

Discussion of Findings

In Theme 2: Continuation and Sequence and Theme 3: Integration of Theory and Practice, both of which relate to the process approach of the curriculum, most of the insights came from faculty, supervisors, and lecturers (North, 2007), with limited input from students. This is expected, as these themes focus on the broader design and flow of the curriculum, areas where faculty play a central role. Faculty are responsible for course sequencing and ensuring that theoretical knowledge is effectively linked to practical skills in the capstone project (Ornstein & Hunkins, 2018).

Faculty raised concerns about gaps in course progression (Theme 2) and difficulties in linking theory to practice (Theme 3). These are curriculum-level issues that impact how they teach and support students. Students may experience challenges related to these themes, such as struggling to apply earlier coursework to their capstone projects. However, they often do not connect these issues to the underlying curriculum structure (Lesko, 2019). This disconnect indicates a need for more explicit communication of how course sequencing and theoretical integration are designed to prepare students for their final projects.

In contrast, students provided more detailed feedback on themes like technical guidance (Theme 5) and independent learning (Theme 4), where they felt the direct impact on their capstone experience. These themes focus on the hands-on support students receive and their ability to take responsibility for their learning. The disparity in feedback between students and faculty highlights their differing perspectives: faculty view the curriculum holistically, while students focus on immediate challenges related to supervision and technical support.

In this context, the MQA (2023, 2024) provides valuable guidelines for evaluating the capstone project. According to the MQA (2023), computing programs must ensure alignment between curriculum design and the industry's evolving demands while fostering student autonomy and developing technical and non-technical skills. The Programme Standards (MQA, 2023) also emphasize the importance of well-structured program development and delivery, clear assessment methods, and continuous improvement in response to student needs and feedback (see also MQA, 2024).

The limitations of this study must be acknowledged. The sample size of 16 participants restricts the generalizability of the findings. Furthermore, the study focuses on a single institution, which limits its scope to one specific IT program. While the findings provide valuable insights, they may not fully represent the experiences of students and faculty in other institutions or programs. Future research with a larger, more diverse sample must validate these trends.

Curriculum innovation in capstone projects depends heavily on collaboration among key stakeholders—faculty, students, and administrators—who must be willing to adapt to changes (Baxter Magolda, 2005; Perez et al., 2012; Bukhari, 2021). Stakeholders' readiness to implement changes is influenced by how they perceive the challenges and their confidence in addressing them. This study suggests that fostering better collaboration between students and faculty, with clearer communication about curriculum design and expectations, could improve capstone project outcomes.

Reflecting on curriculum models, Ornstein and Hunkins (2018) emphasize that faculty and curriculum development teams should ask critical questions, such as whether foundational concepts are emphasized early enough and whether the curriculum aligns with students' needs and societal trends. Evaluating whether students perceive relevance and continuity throughout the program is essential for improving their learning experience (Anderson et al., 2010). Moreover, the MQA standards stress that program providers should focus on fostering graduates with the skills and competencies that meet current industry needs while allowing for innovation in curriculum design and educational delivery (MQA, 2023).

The findings of this study align with previous research on capstone projects (Hauhart & Grahe, 2015), highlighting the importance of integrating practical skills throughout the curriculum. However, this study offers new insights into the challenges specific to IT programs, where technical skills like programming and database management are essential but unevenly taught across different majors (Lesko, 2019). The ambiguity in faculty roles also reflects broader issues in faculty-student collaboration (Perez et al., 2012), reinforcing the need for clearer supervision and curriculum design guidelines.

Conclusion and Recommendations

This study has gathered valuable perspectives from both students and faculty, demonstrating the significant potential of the IT capstone project to enhance students' learning and skills. However, the current design and implementation of the capstone project lack alignment with core curriculum principles and best practices outlined by Ornstein and Hunkins (2018) and the MQA Programme Standards for Computing (2023). This study provides insights and recommendations that can inform curriculum review and improvement.

High-impact educational Practices (HIEPs) such as capstone projects offer students authentic, real-world experiences that improve their skills and prepare them for the workforce (Baxter Magolda, 2005). However, to realize this potential, capstone projects must offer meaningful, applied learning experiences with clearer roles and expectations for students and faculty.

One key recommendation is to clarify supervisors' and lecturers' roles and responsibilities. The current ambiguity, particularly regarding the supervisor's role as a "client" in some projects, creates confusion and inefficiencies. Clear definitions of roles and responsibilities should be communicated, especially during orientation. Supervisors should also be involved in early interactions with students to build strong relationships and provide continuous guidance throughout the project.

Additionally, aligning project assignments with students' skills and interests is crucial. Allowing students to choose capstone topics based on their strengths and the core courses they have completed will ensure a better match between their technical capabilities and project requirements. Moreover, offering project options such as web-based or mobile development to students with relevant skills can enhance engagement and learning outcomes.

Another suggestion is for the Course Coordinator to organize workshops focused on the key skills required for Project 1 and Project 2. These workshops would provide hands-on training and help students develop the technical and essential (Bukhari et al., 2021; Lunt et al., 2008) competencies needed for successful capstone completion. This aligns with the MQA's emphasis on ensuring students are equipped with the necessary skills to meet current and future industry demands (MQA, 2023, 2024).

Finally, offering the capstone project as a final-year project or integrating it with industrial training could give students more time to immerse themselves in real-world problems, enabling deeper learning and collaboration with industry partners.

In conclusion, this study identifies several areas where the IT capstone curriculum can be improved. By clarifying roles, aligning project assignments with students' abilities, and providing more practical training, the capstone experience can better prepare students for professional success. These recommendations are consistent with broader discussions in the Scholarship of Teaching and Learning (SoTL) about enhancing student engagement and learning outcomes through well-designed capstone projects (Felten, 2013). Aligning with the MQA Programme Standards for Computing (2023) will ensure that graduates possess the skills and competencies required for academic and industry success.

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