

Experiential Learning in Action: How Design-Build-Test Projects Impact VTE Students' Academic Motivation and Learning

Ahmad Ikhwanuddin Haji Ali¹, Jabaidah Bungsu², Masitah Shahrill^{2*}

¹ IBTE Nakhoda Ragam Campus, Institute Brunei Technical Education, Km. 13, Lebuhraya Muara-Tutong, Lambak Kanan, Bandar Seri Begawan, BC2515, BRUNEI DARUSSALAM

² Sultan Hassanah Bolkiah Institute of Education, Universiti Brunei Darussalam, Jalan Tungku Link, Gadong, Bandar Seri Begawan, BE1410, BRUNEI DARUSSALAM

*Corresponding Author: masitah.shahrill@ubd.edu.bn
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Abstract

Students in Vocational and Technical Education (VTE) often struggle to connect theoretical knowledge with practical applications, leading to low academic motivation. Academic motivation is essential in shaping students' future careers. Students' passion and motivation while pursuing their studies may fade over time. Therefore, a strategy is needed to cultivate academic motivation and hone their passion for learning. Relating theory to practice in construction course is crucial to prepare students to meet industry needs. One of the strategies is implementing a Project-Based Learning (PBL) model such as Design-Build-Test (DBT) activities in this study involving a purposive sampling of Higher National Technical Education Certificate students from the Institute of Brunei Technical Education. This action research is aimed to evaluate the impact of implementing DBT projects on the students' academic motivation. A mixed-method data collection technique was employed to examine students' motivation levels and learning experiences before and after intervention: Academic Motivation Scale, field observations, semi-structured interviews, and lesson video recordings. Quantitative and qualitative data analyses of changes in academic motivation, common patterns of actions and behaviour via field observation checklists, and thematic analysis of students' perceptions towards the implemented DBT project were carried out. Results from the analyses showed substantial improvements in students' academic motivation through students' collaboration in the DBT project, experiential learning, and opportunities it offered to students in relating theory and practice in construction field. The DBT projects strengthen connection between theoretical knowledge and practical applications, link gaps between conceptual understanding and competency skills in the students' learning. The implication of this research findings showed the relevance of DBT projects in fostering experiential learning, and also provided evidence-based strategies for enhancing academic motivation, and useful contribution for improving curriculum design in construction programme, and career preparation to meet industry needs.

1. Introduction

Students in Vocational and Technical Education (VTE) often struggle to connect theoretical knowledge with practical applications, leading to low academic motivation. Academic motivation plays a crucial role in shaping students' engagement, and overall success in VTE (Filgona et al., 2020; Lin et al., 2024). Students' passion and motivation while pursuing their studies may fade over time. Therefore, a strategy is needed to cultivate academic motivation and hone their passion for learning. Relating theory to practice in construction course is crucial to prepare students to meet industry needs. Many VTE students face challenges in maintaining motivation throughout their studies, particularly in construction and civil engineering programmes (Grigg, 2018; Owais et al., 2020). One effective approach to enhancing hands-on learning in VTE is the Design-Build-Test (DBT) approach, which encourages students to apply theoretical knowledge through iterative design, building, and testing processes. As Dewey (1986) emphasised that experience is one of the greatest teachers in education, reinforcing the need for VTE students to learn through hands-on experiences to develop competency in their fields.

Moreover, educators continue to face similar challenges in adopting effective strategies to enhance students' workforce readiness and skill development. The Institute of Brunei Technical Education (IBTE) has actively implemented various initiatives to enhance teaching and learning in VTE (Goh & Paryono, 2024). A key factor influencing student success is their level of motivation, which directly impacts their ability to develop competencies and engage meaningfully with their studies. However, personal observations and feedback from students indicate that many students did not choose to enroll in their programme based on personal interest but rather due to external influences such as family, friends, or academic placement decisions. Consequently, these students often struggle with low intrinsic motivation, which can hinder their ability to link theoretical knowledge to practical applications. Limited hands-on exposure further exacerbates this issue, potentially affecting students' career direction and preparedness for evolving industry demands.

To address these challenges, this study explores the Experiential Learning (EL) model, which has been widely recognised for its effectiveness in bridging the gap between theory and practice in VTE. Specifically, this action research is aimed to evaluate the impact of implementing DBT projects on the students' academic motivation and experiential learning. It seeks to identify how hands-on, experiential learning interventions influence student motivation, engagement, and learning outcomes in construction-related courses.

The DBT approach, a type of Project-Based Learning (PBL) strategy, mirrors real-world construction processes and has the potential to enhance students' learning experiences by providing meaningful, hands-on engagement. Research suggests that EL models foster motivation, problem-solving skills, and deeper learning experiences by immersing students in realistic, applied learning environments. Given the importance of academic motivation in shaping students' future careers, implementing structured PBL models such as DBT may serve as a viable strategy to cultivate long-term interest and passion for learning in the VTE programme, such as improving curriculum design or providing evidence-based strategies for enhancing academic motivation. Considering student motivation issues and difficulties in linking theory and practice, Ratelle et al. (2007) studied the fact that academic motivation and meaningful learning can be improved by cultivating experiences that nurture the classroom learning environment. Figure 1 describes the conceptual framework to overcome the problems mentioned previously. With the above-presented challenges and issues relating to students' academic motivation, three research questions were addressed in this study, and the corresponding objectives are listed in Table 1.

Table 1 *Research questions and objectives*

Research Questions	Research Objectives
1. What are the effects of DBT projects on the students' academic motivation?	To find out the students' level of academic motivation before and after experiencing the intervention.
2. What are the VTE students' perceptions of DBT projects?	To investigate the students' perceptions of their experiences on the DBT projects. To find ways to foster motivation in students.
3. How has the DBT experience impacted the students' academic motivation?	To examine the effects of DBT projects in improving students' academic motivation.

Under the action research framework of planning, acting, observing and reflecting on data, where in this study, the instructor was also acting as the researcher (the first author), the students were facilitated in participating in the DBT project (intervention) to construct a water tower using limited materials provided by the instructor. The collected data was a mixture of quantitative and qualitative data, utilising instruments such as questionnaires, observation checklists, and interviews. From the intervention, it was hoped that the expected outcomes from this action research were (1) an increased level of students' academic motivation, (2) improvement in students' knowledge in the construction process, and (3) future utilisation of ready-to-use DBT projects for other

instructors to use, which will benefit students in terms of quality learning and readiness for their future careers in the construction field.

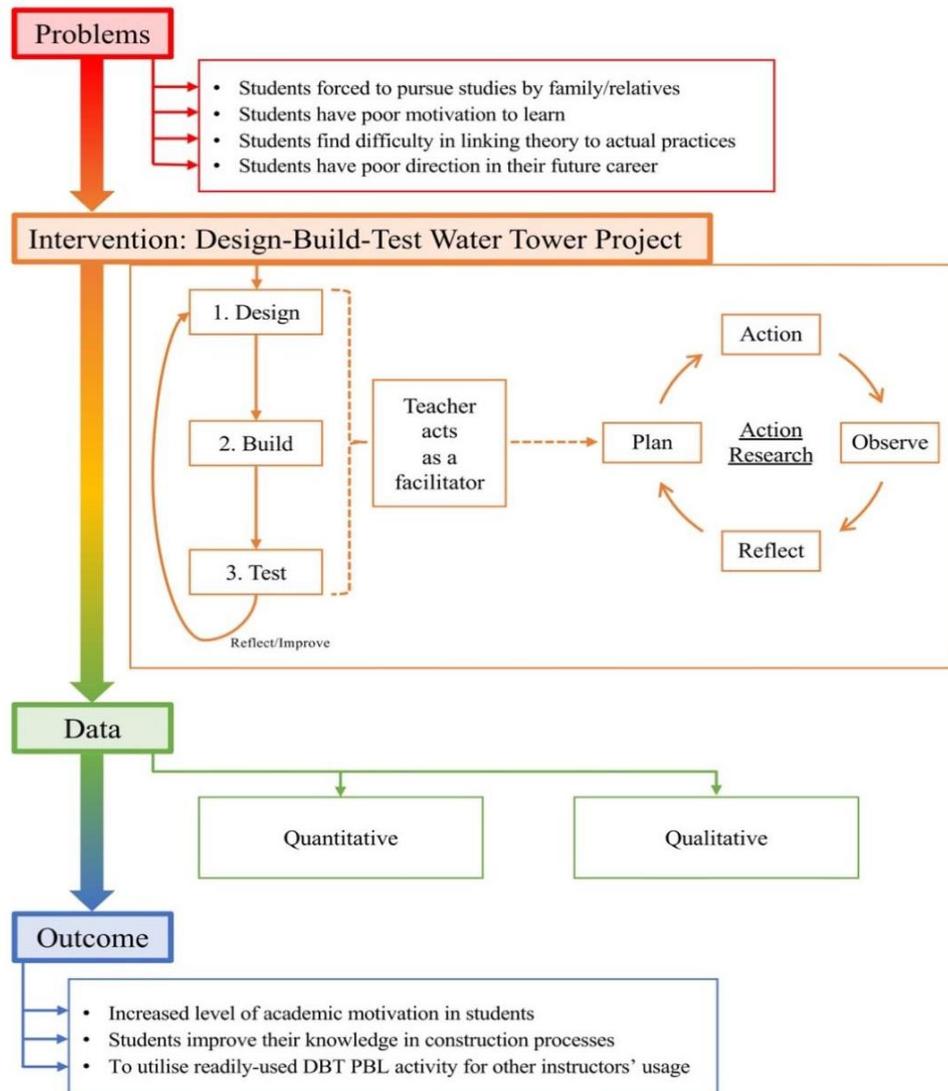


Fig. 1 Conceptual framework of the action research

2. Literature Review

2.1 Academic Motivation

Motivation is an essential psychological concept in education related to students' academic performance (Fong et al., 2024; Daniel et al., 2024; Vallerand et al., 1992). In the mid-1980s, Deci and Ryan (2008) built their famous work on Self-Determination Theory (SDT). They identified SDT as having three types of motivation, namely: (1) autonomous motivation, in which people integrate the activity into their sense of self-belonging; (2) controlled motivation, whereby a person's behaviour is heavily dependent on external influences; and (3) Amotivation, which is the lack of motivation. SDT denotes different levels of motivation. It also highlights sub-categories of the level of regulation that occurs in a person, including non-regulation, external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic regulation, as shown in Table 2.

Hence, the reflection element is missing from the cycle (Quesada et al., 2020). In addition, other challenges are also present, such as poorly trained instructors or teachers, poor learning environment, poor connection of theory to practice, students' unwillingness to participate, lack of programme support, inadequate equipment and material maintenance, poor class management, and lack of facilities (Clark et al., 2010; Hulaikah et al., 2020; Nooghabi et al., 2011). Hence, it is essential that proper lesson planning is done, communication within the institution is maintained, EL opportunities are provided, and all students are provided with access to the entire, complete EL cycle so that students develop a wide range of knowledge and skills.

EL is chosen here in this study as the experiences gained in EL activities are directly involved in creating a context relevant to the student's future careers (Yardley et al., 2012). As reported in many prevailing literature, there are many benefits in the usage of EL, such as high level of engagement, retention of knowledge, increase in performance, instilling lifelong learning, connecting theory to practice, practical competence, professional networking, cultivates the students' learning responsibility, and provides context to real-world problems (Baden & Parkes, 2013; Coker & Porter, 2015; Dancz et al., 2018; Knobloch, 2003; Kolb & Kolb, 2009; Lee et al., 2008; Lewis & Williams, 1994; Schechtel et al., 2020; Woods, 2011; Yardley et al., 2012). Besides that, many learning activities fall under the umbrella of EL, such as problem-based learning, PBL, case-based learning, and inquiry-based learning. Hence, in this action research, PBL was more focused and selected to engage students in their DBT activities appropriately.

2.1.2 Project Based Learning

PBL is a student-centred approach that connects knowledge with context, which is essential for students to construct their learning (Lea et al., 2003; Maspul, 2024; Quinapallo-Quintana et al., 2024). VTE graduates are now facing significant challenges in the 21st-century to survive in the industry (Utvær & Haugan, 2016). Therefore, having the relevant competency itself may not be sufficient, as there has been a recent requirement for other 21st-century skills. Concurrent to this, PBL has excellent benefits in cultivating interpersonal skills required in the 21st-century workplace and, thus, has a great potential to enhance students' motivation to learn and help prepare them to work in the real world (Fajra et al., 2020; Hegazy et al., 2020; Lea et al., 2003; Megayanti et al., 2020; Mosleh & Shirvani, 2017).

In contrast, research has shown that the socially interactive aspect of PBL may lead to noisy classes that lack focus (Dear, 2016). To avoid this, the PBL activities must be well-planned and structured so students can reap the benefits. Generally, the framework of PBL activities should include elements such as (1) curriculum-related, (2) focused on problems that bring students to the central issue, (3) involve students in knowledge inquiry, (4) highly student-driven, and (5) are realistic, reflecting real-world situations with the importance of collaboration, presentations, reflections, discussions and students' hands-on active involvement in the process (Kokotsaki et al., 2016; Mosleh & Shirvani, 2017). Appropriate logistics, resources, materials, and facilities are essential in implementing PBL activities. During the COVID-19 pandemic, research has also proven that PBL can be done online, and it is more efficient in implementation, fosters characteristics of students, interdisciplinary skills, management skills, and interpersonal communication (Edy et al., 2020). This affirms the possibility of including certain online elements in the PBL activity.

Working on a group project also requires specific roles to be fulfilled. Various reports have suggested many advantages in distinguishing specific roles in team tasks, such as increasing peer engagement, motivating students' learning and leadership practice, and supporting effective teamwork (Wu et al., 2020). With endless possibilities in the design of the PBL activity, this action research focuses on using the DBT projects, which are highly relevant in the construction sector.

2.1.3 Design-Build-Test Projects

The DBT approach is a form of PBL that has been widely recognised for enhancing student engagement, critical thinking, and hands-on learning experiences (Mosleh & Shirvani, 2017; Pleasants & Sartin, 2024). Unlike traditional lecture-based teaching methods, DBT projects require students to actively participate in problem-solving, design, construction, and testing phases, making learning more experiential and applied. This aligns well with VTE, where students must develop industry-relevant competencies through practical, real-world applications.

A persistent challenge in construction-related education is ensuring that the curriculum remains relevant to industrial practices and prepares students for real-world problem-solving (Grigg, 2018). The DBT framework, comprising the stages of design, build, and test; mirrors the construction workflow, allowing students to bridge the gap between theoretical knowledge and practical execution. To maximise the benefits of DBT projects, certain guidelines must be followed: (1) clearly communicating learning objectives, (2) ensuring an accessible and structured approach to project components, (3) fostering student motivation through healthy competition, (4) setting well-defined project requirements, (5) providing continuous mentorship and feedback, and (6) utilising validated project designs to guide student learning (Hegazy et al., 2020).

Several studies have explored the implementation of DBT projects across different educational levels, such as mini dams (MacVicar et al., 2020), tower designs (Bazler, 2020), universal testing machine prototypes (Mosleh & Shirvani, 2017), and miniature bridge trusses (Brake et al., 2018). While these studies have demonstrated positive learning outcomes in primary, secondary, and higher education, there remains a lack of research specifically focused on DBT’s impact within VTE settings. Given the unique demands of technical and vocational learners, more research is needed to explore how DBT can be adapted to cultivate motivation and industry-specific competencies in VTE students (Deci & Ryan, 2008).

3. Method and Material

A group of students selected via convenient sampling were chosen as the participants. These students were the first author’s students during their studies in the Higher National Technical Education Certificate (HNTEc) programme in IBTE. This study was executed using a mixture of physical (face-to-face) and online components depending on the relevant DBT stage in the project and the role assigned to each student. HNTEc is equivalent to Diploma level 4 in the post-secondary multi-pathways (Ebil & Shahrill, 2023; Goh & Paryono, 2024), as shown in Figure 2 (Ministry of Education, 2014, p. 9).

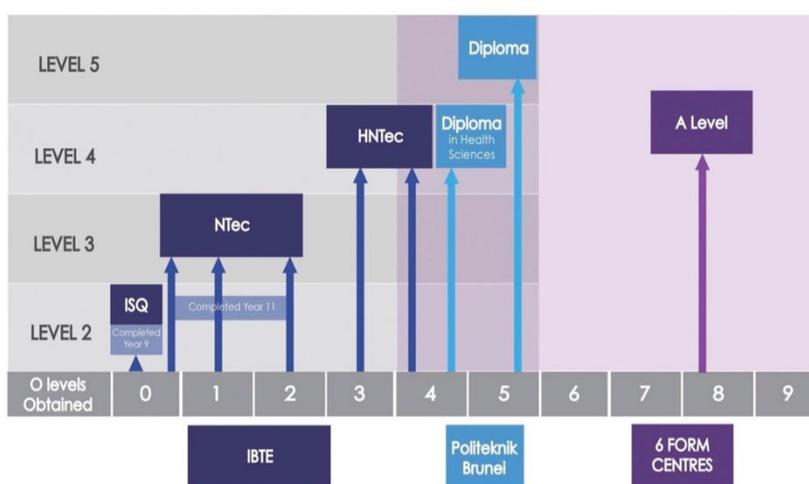


Fig. 2 Post-secondary multi-pathways in Brunei Darussalam

Prior to the actual study, a pilot study was performed on a different group of students of the same programme in the same intake. The questionnaire was piloted to identify appropriate changes needed for the reliability check of the item based on their feedback. The actual study was implemented in several stages: (1) pre-intervention, (2) intervention, and (3) post-intervention. The actual student participants responded to the AMS questionnaire during the pre-intervention stage (as well as later in the post-intervention stage). This was followed by the DBT project in the intervention stage, data analysis and deduction of the research findings.

Table 4 The roles in the DBT project and the detailed description of the respective roles

Role	Description	Stages involved	Presence
Project Manager (1 per team)	1. The leader of the group that is involved from start to finish of the project 2. Is in charge of the group’s progress and success 3. Manages the team to provide effective collaboration	All Stages (Design stage, Build stage, Testing stage, Regroup, Post-Testing Reflection, Design Improvement)	Physical presence in campus may be required in the Build stage, Testing stage, Design Improvement (Up to Project Manager’s discretion and group’s decision)
Architect (1 per team)	1. Is the main focal person in charge of the design of the structure 2. The main member tasked to create the design pack (.pdf or paper drawing) for the builders to refer to during building	Design Stage, Regroup, Post-Testing Reflection	No physical presence in campus required

Builders (2 -3 per team)	1. In charge of all constructing/building aspect in the project 2. Is tasked to execute/build the structure according to the design created by the architect	Build stage, Regroup, Post-Testing Reflection and Design Improvement	Physical presence in campus required in the Build stage and Design Improvement stage
Inspector/ Evaluator (1 per team)	1. In charge of reporting the progress of the structure during the testing stage 2. Main focal person to compile any feedback during the testing stage for the group's usage in the Design Improvement stage.	Testing stage, Regroup, Post-Testing Reflection, Design Improvement	Physical presence in campus required in the Testing stage

The students were grouped into five to six members per group and given choices on their specific roles throughout the DBT activity. The roles were (1) Project Manager, (2) Architect, (3) Builders, and (4) Inspector/Evaluator. A detailed description of the roles can be found in Table 4. Each role had separate tasks essential to the group's success. Student groups were given an exact number of materials (wooden sticks and masking tape) and designed, built and tested their water tower designs.

This study employed a mixed-methods approach, integrating both quantitative and qualitative data collection techniques to examine students' motivation levels and learning experiences throughout the DBT project. The research focused on three key aspects: (1) students' motivation levels before and after the intervention, (2) in-depth perceptions of the project experience, and (3) students' behavioural and emotional engagement during activities.

For quantitative data collection, the Academic Motivation Scale (AMS) adapted from Vallerand et al. (1992) was used to measure students' intrinsic and extrinsic motivation, along with their sub-categories. The AMS questionnaire consisted of 28 items and was administered twice – before and immediately after the implementation of the DBT project. To ensure the reliability of the instrument, a pilot test was conducted with students from other classes in the same programme and intake. The students' motivation levels before and after the intervention were analysed using a paired T-test to determine statistical significance.

The qualitative aspect of the study involved field observations, semi-structured interviews, and video recordings to gain deeper insights into students' motivation and engagement. In the field observations, students' behavioural data were collected throughout all DBT stages using a field observation checklist that focused on four key dimensions: participation, behavioural, emotional, and cognitive engagement (Azim et al., 2021). Observations were conducted during live lessons and through recorded video sessions. For the semi-structured interviews, the interviews targeted students exhibiting high, moderate, and no or negative changes in motivation levels. The interview protocol was piloted with students from the same class to refine the questions before the actual data collection. These interviews provided an in-depth understanding of students' learning experiences and their perspectives on motivation changes throughout the DBT project.

In the post-intervention analysis, after the students' DBT projects, a second AMS questionnaire was administered alongside follow-up interviews. The interview responses (conducted via WhatsApp, MS Teams, and other online platforms) were analysed using thematic coding to identify key themes and sub-themes related to students' motivation changes. Majority of students preferred WhatsApp over other interview formats (physical, phone call, or video call), as they found it the most comfortable communication medium.

By combining quantitative analysis (paired T-test of pre- and post-intervention AMS results) with qualitative insights (field observations and semi-structured interviews), this study provides a comprehensive understanding of the impact of the DBT approach on student motivation in VTE.

4. Results

For this section, the results for each of the three respective research questions are presented, and the findings are separately discussed towards the end. To answer the first research question (How do DBT projects affect the student's academic motivation?), the individual pre- and post-intervention questionnaire results of the student's total academic motivation level were used. To evaluate the effects of DBT projects on students' academic motivation, a comparison was made between students' total academic motivation from the pre- and post-intervention of the AMS questionnaire. The total value of motivation was calculated by adding the sum of intrinsic and extrinsic motivation minus the motivation values. Figure 3 presents the results.

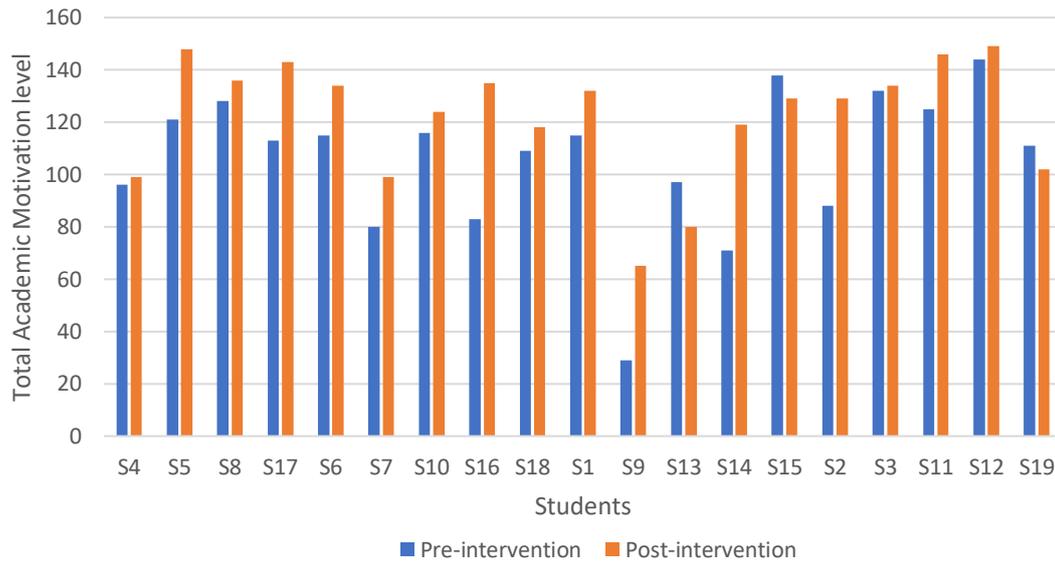


Fig. 3 Students' pre- and post-intervention questionnaire scores

The results show significant positive improvements in total academic motivation in all students except for students S13, S15, and S19, whose total academic motivation did not improve. Table 5 shows further analysis of the students' total academic motivation scores in the pre- and post-intervention questionnaire and the difference between these scores.

Table 5 Students' individual total academic motivation scores

Group	Student	Pre-intervention	Post-intervention	Difference (Post-Pre)
Group 1	S4	96	99	3
	S5	121	148	27
	S8	128	136	8
	S17	113	143	30
Group 2	S6	115	134	19
	S7	80	99	19
	S10	116	124	8
	S16	83	135	52
	S18	109	118	9
Group 3	S1	115	132	17
	S9	29	65	36
	S13	97	80	-17
	S14	71	119	48
Group 4	S15	138	129	-9
	S2	88	129	41
	S3	132	134	2
	S11	125	146	21
	S12	144	149	5
	S19	111	102	-9

Note:

- Selected high improvement student for interview
- Selected middle improvement student for interview
- Selected low improvement student for interview

Improvement:

- High 29 to 52
- Middle 7 to 28
- Low -17 to 6

These sets of results were also used as the basis for the researcher to select which students to interview to address the other research questions in this study. Two high improving students were willing to be interviewed. Students S2 and S14 greatly improved by +41 and +48 points, respectively. For the low-improving students, students S9 (with a -9 score difference) and S13 (with a -17 score difference) who did not show improvements were willing to be interviewed. Unfortunately, there were difficulties in interviewing middle improvement students because they were all unwilling to be interviewed. Instead, the following available students in this category willing to be interviewed were students S4 and S12, with improvement scores of +3 and +5, respectively. The data from the total motivation was initially tested for normality using the Shapiro-Wilk normality test since the number of participants (N=19) is considered small. The results are shown in Table 6 below.

Table 6 Shapiro-Wilk test of normality result

	N	Mean		S. Normality		Outliers Yes or No?
		Pre-intervention	Post-intervention	Skewness	S. Wilk	
Total academic motivation	19	105.8	122.2	0.191	0.849	No

The means from the pre- and post-intervention questionnaire scores were calculated at 105.8 and 122.2, respectively. The data skewness was 0.191, and the computed p-value from the Shapiro-Wilk test was 0.849. The p-value from the Shapiro-Wilk test (0.849) is far greater than 0.05, showing that this data can be considered normally distributed. In addition, the histograms, boxplots, and normality plots have shown that the data is normally distributed, and the skewness was not evident. This preliminary analysis has suggested that a parametric test can be further used to support the analysis of differences between pre- and post-intervention scores from the questionnaire and the sub-scales, including intrinsic, extrinsic, negative motivation, and total motivation.

A paired t-test was then used to evaluate the effect of DBT on students' academic motivation for the same group that was tested twice using the pre- and post-intervention questionnaires. This provided the basis for measuring statistical differences in the data obtained from the first research question. The statistical significance of the differences according to the various categories of motivation sub-scales will be further presented in the next part of this section. For reliability measures of academic motivation used in the AMS questionnaire in this study, the Cronbach Alpha (Single Test) was found to be 0.83. This indicated that the implemented AMS questionnaire had a perfect internal consistency, as anything above 0.8 can be considered to have a high internal consistency. Similarly, this was also reported in previous studies by Vallerand et al. (1993).

Paired t-test analyses were performed for the three sub-scales of total academic motivation (intrinsic, extrinsic, and Amotivation) and total academic motivation. The paired t-test analysis performed at a 95% confidence level for all four categories showed promising results. The results are shown in Table 7 below.

Table 7 Paired t-test and effect size results

Variable	Pre-intervention		Post-intervention		t	df	p-value	Effect size (Partial ETA squared)
	Mean	SD	Mean	SD				
Intrinsic motivation	54.8	13.9	63.8	12.1	4.282	18	**0.0005	0.506
Extrinsic motivation	59.0	13.6	67.5	11.1	3.560	18	**0.0022	0.413
Amotivation	7.89	5.13	9.21	5.00	0.997	18	0.3321	0.052
Academic motivation	105.8	27.3	122.2	23.3	3.685	18	**0.0017	0.430

Note. * $p \leq 0.05$ (significant) & ** $p \leq 0.01$ (highly significant)

The paired t-test analysis showed that there was a very high significant increase in intrinsic motivation from the pre-intervention questionnaire (Mean = 54.8, SD = 13.9) to the post-intervention questionnaire (Mean = 63.8, SD = 12.1), $t(18) = 4.282$, $p < 0.01$. The effect size for intrinsic motivation using partial ETA squared $\frac{t^2}{t^2 + (N-1)}$ was 0.506, which showed a medium effect size. According to Cohen et al. (2018), a value of around 0.5 can be considered a medium effect. Hence, this would mean that the findings from the intrinsic motivation significantly impact the DBT intervention.

For the extrinsic motivation, there was also an increase of high significance from the pre-intervention questionnaire (Mean = 59.0, SD = 13.6) to the post-intervention questionnaire (Mean = 67.5, SD = 11.1, $t(18) = 3.560$) with a medium effect size of 0.413, which is a positive finding, supporting the encouraging results from the

intrinsic motivation. On the contrary, the Amotivation (the opposite of being motivated), showed a non-favourable result as the Amotivation increased where it should not have. This is unfavourable as the students should be less motivated after the DBT intervention. The Amotivation increased from pre-intervention questionnaire (Mean = 7.89, SD = 5.13) to post-intervention questionnaire (Mean = 9.21, SD = 5.00), $t(18) = 0.997$, $p > 0.05$). However, the effect size of 0.052 was very small and insignificant. Hence, the DBT intervention had little impact on the students' Amotivation.

Overall, the paired t-test for the total academic motivation showed that there was a highly significant increase in the student's total academic motivation from pre-intervention questionnaire (Mean = 105.8, SD = 27.3) to post-intervention questionnaire (Mean = 122.2, SD = 23.3), $t(18) = 3.685$, $p < 0.01$). The partial ETA squared statistics of total academic motivation (0.430) suggested a medium effect size. Therefore, this would mean that the findings from the total academic motivation have a significant impact after the DBT intervention. This analysis showed very good results from the implementation of the DBT project. Figure 4 below illustrates the summary findings from the three sub-categories of motivation and total academic motivation.

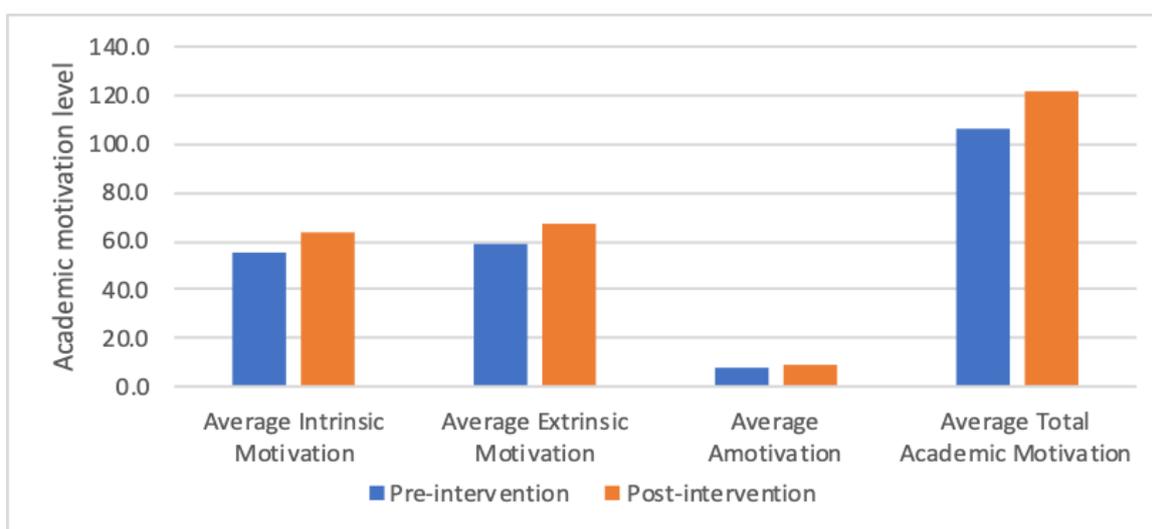


Fig. 4 Students' average motivation sub-scales and total motivation

This section answers the second research question (What are the VTE students' perceptions of DBT projects?) and the findings from the interview analysis of six students: two least improved students (indicated by red highlight), two moderately improved students (indicated by yellow highlight), and two highly improved students (indicated by green highlight) in terms of their changes in total academic motivation from pre- to post-intervention results of the AMS questionnaire. The overall summary of the thematic analysis of their interviews can be found in Table 8, and yielded four themes and eight sub-themes from the interview analysis.

Table 8 Summary of thematic analysis for research question 2

Main Themes	Sub-Themes	S2	S4	S12	S13	S14	S19	Sub-Themes Total Frequency	Total (%)
1. Positive feelings	Enjoyment		/	/	/	/	//	6	53.3
	Excited					/		1	
	Great experience	/						1	
2. Perceived difficulty	Simple project (teacher needs to increase challenges)			/			/	2	26.7
	Challenging tasks	/			/			2	
3. Negative feelings	Nervous					/		1	13.3
	Panic (poor resource management)		/					1	
4. Self-Improvement	Determined to improve					/		1	6.7

The third research question is, how has the DBT experience impacted the students' academic motivation? Here, insights from the students were gathered to investigate the effects of DBT projects in improving students' academic motivation. This was done through a set of semi-structured interviews, targeting two least improved students (indicated by red highlight), two moderately improved students (indicated by yellow highlight), and two

highly improved students (indicated by green highlight) in terms of their changes in total academic motivation from pre- to post-intervention scores of the AMS questionnaire. The overall summary of the thematic analysis of their interviews can be found in Table 9 below.

Table 9 Summary of thematic analysis for research question 3

Main Themes	Sub-Themes	S2	S4	S12	S13	S14	S19	Sub-Themes Total Frequency	Total (%)
1. Collaborative aspect of DBT	Group Work								
	Collaborative activities		/	/	/		/		
	Communication amongst group members	/			/				
	Teamwork	/			/			11	
	Open group discussion				/				
	Good group leadership	/							
	Strong bond amongst team members	/							51.5
	Skills practiced in DBT								
	Sharing of good ideas		/		/				
	Gaining relevant knowledge and skills				/				6
Practicing soft skills						//			
Real-life problem solving						/			
2. Enjoyment	Enjoyment			/	/	/	/	4	12.1
3. Experience gained	Learning from experience		/			//	/	4	12.1
4. External Influence	Competitiveness amongst groups	/		/				2	9.1
	Getting high score	/						1	
5. Challenges within DBT	Challenges during the activity			/	/			2	9.1
	Resource management		/					1	
6. Rewards	Reward strategy - gifts	/						1	3.0
7. Student self-improvement	Observable improvements		/					1	3.0

During the stages of the DBT project, the students were observed using a checklist. Some items observed were students' physical actions, reactions, and interactions with other students. All this is aimed at understanding better the effects of DBT projects on students' academic motivation, finding ways to foster motivation in students, and examining the impact of DBT projects in improving students' academic motivation, which consists of the objectives of all three research questions in this study in the form of triangulating the data between the instruments used. During students' DBT activities, the researcher was a complete observer and only observed the students without interfering with their progress and tasks, as seen in Figure 5. The DBT project's six stages (design, build, testing, regroup, design improvement, and final testing stage) were observed.



Fig. 5 Field observation setting

From the observational checklist, student S17 from Group 1 showed a lack of participation in group discussion, not feeling particularly happy, not providing constructive feedback, and not feeling energetic throughout most of the DBT project stages. One of the leading causes for this may be that more females should be in that group to balance the genders. Hence, the male dominance in Group 1 may have caused student S17 to feel overshadowed and less able to provide ideas and the help that the group needs. Overall, this group was placed last, as their design could have been better thought out, and they needed help to complete their structure to the required strength standard.

Students S1 and S9 were slacking off together in Group 3, especially during the design stage. These two students seemed to be close friends. Rather than focusing on the task, they were found to be passive in participation, not concentrating well on the activity, needing better energy and enthusiasm, not enjoying the activity, and not expressing positive opinions. Although they actively participated during the build and testing stage, they seemed distracted relatively easily by external influences irrelevant to their DBT task. It is also worth mentioning that during the two-day DBT project, one student, S13, was absent due to COVID-19 infection and was on quarantine on the first day, hence missing the initial few stages of the DBT project. Overall, this group managed to get third place in the DBT project.

Group 2 showed positive behaviour overall. All the group members actively participated in all of the DBT stages. They were pleased with each other and their contributions and thoroughly enjoyed the DBT project. The task was done very well, and each group member provided constructive feedback to each other, improving their performance. Their performance landed them second place in the final testing stage.

Student S3 in Group 4 showed poor behaviour throughout all DBT stages but did not affect the group's performance. Student S3 seemed to be generally passive in contributing ideas and hands-on tasks. In addition, the student was not actively participating in the activity, not focusing well, not paying good attention to tasks, not being a team player, having poor energy and enthusiasm, not helping fellow group members, not performing tasks well, and not providing constructive feedback. Student S19 in Group 4 was also distracted reasonably easily by other students and started to lose focus towards the end of the DBT project. Despite student S3 being a poor team player and student S19 being distracted easily, this group managed to gain first place overall in the DBT project due to the innovativeness and teamwork of the other group members and the contribution of ideas and suggestions for the structure of their project.

5. Discussion

The results from the AMS questionnaire administered before and after the DBT project indicated a statistically significant improvement in students' overall academic motivation. This suggests that the EL aspect of DBT provided students with a relevant and reflective learning experience (as in Kolb and Kolb, 2009), reinforcing the notion that learners construct meaning from their experiences (Clark et al., 2010). Additionally, the authentic context of constructing a water tower within the DBT project increased student engagement and curiosity in construction, which aligns with previous research on fostering and maintaining student academic motivation (Utvær & Haugan, 2016).

However, three students showed decreased motivation due to various uncontrollable factors. One student, absent on the first day due to COVID-19 quarantine, felt left out and disengaged. Another student, observed to be easily distracted, initially exhibited high motivation that declined over time. The third student experienced a lack of collaboration within their group, which negatively impacted their learning experience. These findings align with prior research suggesting that individual attitudes towards DBT projects vary and that educators must address diverse learning needs to optimise engagement (Tartibu & Steenkamp, 2020). Addressing these issues could involve increasing awareness of group dynamics and personal learning attitudes to enhance the DBT experience.

Interview analysis provided valuable insights into students' perceptions of the DBT project. Despite varying degrees of motivation improvement based on AMS scores, students generally enjoyed the project and found it engaging. Effective project design and implementation are critical to ensuring meaningful learning experiences (Tartibu & Steenkamp, 2020). Students also expressed a heightened determination to improve their skills, as their success throughout the project instilled a sense of accomplishment. Prior research supports this notion, indicating that students' motivation and attitudes improve when they experience a tangible sense of achievement (Nursin et al., 2018; Tartibu & Steenkamp, 2020).

A minority of students suggested incorporating greater challenges into the DBT project, as they found certain tasks relatively easy. This highlights an opportunity to enhance the project by introducing elements that cater to high-performing students. One potential approach could be allocating a budget for teams to purchase additional materials to strengthen and enhance their tower designs, as suggested in previous studies (Mosleh & Shirvani, 2017).

The findings also emphasised the collaborative nature of DBT is a key factor in boosting student motivation. In construction, teamwork is essential for project success within set specifications, budgets, and deadlines. The DBT project encouraged students to work together, exchange ideas, and practice essential soft skills while solving

real-world construction challenges. This aligns with existing literature, which highlights that active collaboration in construction projects enhances learning outcomes (Nursin et al., 2018).

Furthermore, the presence of healthy competition among student groups emerged as a significant motivational factor. The desire to outperform peers and produce the best final product heightened students' engagement and enthusiasm. Seeing tangible results from their efforts reinforced their drive to acquire more knowledge and refine their skills. Previous research supports the idea that DBT, as a form of PBL, enhances students' enthusiasm, creativity, and overall learning effectiveness (Fajra et al., 2020; Hegazy et al., 2020; Megayanti et al., 2020; Mosleh & Shirvani, 2017).

Overall, the findings suggest that DBT projects effectively improve academic motivation and strengthen the connection between theoretical knowledge and practical application. By fostering long-term engagement and deeper learning in the construction field, DBT has the potential to produce high-quality VTE graduates, contributing to the future development of the construction industry in Brunei Darussalam.

6. Conclusion and Implications

The use of DBL projects as an EL strategy effectively bridges the gap between theory and practice. EL plays a vital role in providing students with hands-on experiences and linking what is learned in theory to what happens in practice. The findings concluded that the students' academic motivation have significantly improved after the DBT projects were implemented. Substantial improvements in students' academic motivation were evident through students' collaboration in the DBT project, experiential learning, and opportunities it offered to students in relating theory and practice in construction field. This study has also found ways to foster and improve students' academic motivation through autonomy in the student's learning process, where the students are in charge of the critical decisions they make throughout the DBT process, as individually and in collaborative group. Furthermore, the study findings show the teaching instructor's important role in providing and facilitating meaningful learning experiences extrinsically, motivating students to transform intrinsically in their academic performance, and hence achieving more significant learning goals towards their career aspirations.

The findings highlight actionable insights for curriculum developers and educators in VTE. The implication of these research findings showed the relevance of DBT projects in fostering experiential learning. Also, it provided evidence-based strategies for enhancing academic motivation and useful contributions to improving curriculum design in construction programmes and career preparation to meet industry needs. Hence, a DBT project, comprising various stages, should be included in the curriculum design of the construction programme and be implemented for VTE students. The DBT projects strengthen the connection between theoretical knowledge and practical applications and link gaps between conceptual understanding and competency skills in the students' learning to the workplace. In addition, students have thoroughly enjoyed participating in the DBT project despite its challenges. Furthermore, DBT projects such as this are an excellent platform for students to practice their rarely utilised soft skills. In contrast, previously, many teachers and instructors missed the opportunity to provide students with soft skills and 21st-century skills in their lessons.

Value-driven EL is key to providing a holistic learning experience for VTE students where students need to embrace lifelong learning, which is the vision of IBTE. Students' motivation must be fostered and appropriately nurtured so that high-quality learning occurs both in and outside the classroom in the student's own time and space. Module instructors in IBTE need to be more aware of EL's power and the benefits it offers, especially in DBT projects and others. This study hoped to encourage other fellow teachers and instructors to adopt such practices to improve students' learning and development of their career pathways, thus increasing their employability to meet the industry's needs.

7. Limitations and Suggestions for Further Study

This study focuses primarily on construction-related VTE programmes and may not be directly applicable to other VTE disciplines. Despite the significant findings above, this research does not intend to generalise to different cohorts of VTE students in other modules due to the small number of participants involved. However, a more comprehensive and significant sample may be required to represent the VTE population in a future study if the study is to be conducted on other VTE programmes. The limited time for this research may also require more extended time in the future to examine its sustainability and get more comprehensive data on students' motivation over time. Future research is also suggested to find ways to improve the DBT activity by employing other innovative ideas to provide relevant and more challenging experiences in the build project activities. Some form of discussions between the module instructors and construction programme leaders need to take place to embed DBT projects like this as part of learning assessment. It may also be necessary to validate project designs for students before implementation in assessment. Having a DBT project as students' EL will provide further opportunities for them to convert what they have learned through theory and apply it into practice. If we need to produce more quality graduates and work-ready, it is imperative to develop students' learning experiences holistically and in relevance to meet industry needs.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the conduct, analysis, or publication of this study.

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Authors' Contribution

Ahmad Ikhwanuddin Haji Ali led the research design and conceptualisation, conducted the fieldwork and data collection, and prepared the initial draft of the manuscript. Hajah Jabaidah Haji Bungsu supervised the study, provided academic guidance throughout the research process, and contributed to the manuscript's structure and refinement. Masitah Shahrill contributed expert input in teacher education, offered detailed feedback, and critically revised the manuscript for journal submission. All authors reviewed and approved the final version of the manuscript.

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