Effectiveness of 6C Skills Activities on Industrial Design Course (RBI)

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Abstract

The purpose of this study is to assess how well the 6C Skills activities are implemented in the Industrial Design (RBI) course at the Faculty of Technical and Vocational Education (FPTV), Universiti Tun Hussein Onn Malaysia (UTHM), regarding the soft skills mastery and project results of the students. Participants included 92 Bachelor of Vocational Education (SMPV) students, 50 of whom were in the treatment group (TG) and 42 of whom were in the control group (CG). 49 TG lecturers and 44 CG lecturers made up the total of 93 lecturers that participated. Project assessments and questionnaires were utilised to gather data for the study, which had a quasi-experimental design. Since the normality test revealed an anomalous distribution of the data, non-parametric statistical tests such the Mann-Whitney U and Wilcoxon Signed-Rank were used to analyse the data. The findings indicated that TG and CG significantly differed in their attainment of student project outcomes ($U = 566.500$, $p < .001$), with TG performing better. A significant increase in TG for all subcomponents was also seen in the post score of 6C Skills competence (Z varied from -5.533 to -5.996, $p < .001$), but the increase in CG was less pronounced. These results demonstrate how well the 6C Skills-based teaching strategy works to enhance 21st-century abilities. This research has significant ramifications for the advancement of TVET pedagogy that is more dynamic, comprehensive, and pertinent to the demands of the future industry.

Keywords: 6C skills, industrial design, vocational education, SMPV students, 21st century teaching

1. Introduction

Globalisation and digitisation have made it necessary for the educational system to generate graduates who are not just knowledgeable but also highly talented and capable of competing on a global scale. According to Anafi and Mohd Noor (2024), technical and vocational education is crucial for supplying skilled labour and preparing students for the demands of the workforce. As a result, the technical education teaching system must be more thoroughly and strategically designed to meet the demands of the industry of the future. It is essential for students to be able to adjust to changes in technology and market demands. In this regard, instructional strategies that incorporate Proficiency 6C are becoming more significant.

Six essential components make up the 6C skills, which work in tandem to create well-rounded pupils who are prepared for the challenges of the 21st century (Munusamy & Gurusamy, 2023). The ability to solve problems and create useful products through the generation of fresh, creative, and original ideas is the first definition of creativity (C1). According to Mohd Shah and Kamaruddin (2022), critical thinking (C2) is the capacity to evaluate information objectively, draw logical conclusions, and make evidence-based decisions. Third, communication (C3) describes students' capacity to express themselves both orally and in writing in a range of settings with clarity and effectiveness (Abdul Mutalib et al., 2023). Fourth, cooperation (C4) highlights the capacity to cooperate, share duties, and respect others' opinions to accomplish shared objectives (Nor Hashim et al., 2025). The fifth aspect of technology literacy is the ability to use information and communication (C5) technology effectively, morally, and

constructively in daily life, work, and education. Finally, citizenship (C6) places a strong emphasis on civic awareness, ethics, and social responsibility. It also stresses students' capacity to actively participate in their community and improve their well-being (Munusamy & Gurusamy, 2023).

The development of student competencies that are comprehensive and pertinent to the demands of the labour market today is based on these six components. As a result, employing Skills 6C-based instruction enhances soft skills, which are crucial in the workplace, in addition to developing technical skills. It is fundamental to learning in the twenty-first century. According to Mohd Nong and Md Osman (2024), these six components assist students in overcoming difficult obstacles in their social and professional lives. These abilities also foster the development of soft skills and reflective thinking, which are necessary in a range of professional settings (Mohd Shah & Kamaruddin, 2022). In addition, learning materials must be combined with a pedagogical style that emphasises problem-solving and real-world application in today's classroom (Lim et al., 2024). Thus, it makes perfect sense to incorporate Skills 6C into technical courses like Industrial Design.

To produce unique design solutions, students enrolled in the Industrial Design (RBI) degree must integrate technical and creative elements (Alli, 2022). Students must become proficient in a variety of areas, including design, visual communication, problem-solving, and collaboration (Mohd Puad & Abu, 2021). Therefore, the teaching efficacy of this course can be strengthened by applying Skills 6C through an organised teaching strategy. Collaborative learning, group discussions, and project-based activities are effective teaching techniques (Basari, 2023a). Learning becomes more relevant and aligns with the demands of the labour market in this way.

The purpose of this study was to evaluate how the use of Skills 6C-based activities affected the performance of students in RBI courses. Additionally, it compares the mastery levels of the pupils before and after the activity was implemented. Additionally, the study compared the academic performance of the students in the Skills 6C intervention group with that of the students in the regular instruction group. It is anticipated that the findings of this study will give educators practical empirical data to help them enhance their teaching methods.

This study's novelty can be summed up in a few important ways that set it apart from earlier research. According to Nor Hashim et al. (2025), Mohd Shah & Kamaruddin (2022), and Abdul Mutalib et al. (2023), most of the research connected to Skills 6C has concentrated mostly on general education or school level. Instead, this study directly implemented the 6C strategy in technical and creative courses at the university level, particularly in the Industrial Design course. This setting was not frequently examined in the literature review that was conducted in Malaysia. This study used the evaluation rubric to measure student project results objectively in addition to evaluating the perceptual mastery of the 6C Skills (pre and post). It offers an evaluation component that is comprehensive and integrates both cognitive and practical accomplishments.

Furthermore, the treatment group's intervention activities were specifically designed using the 6C elements; creative projects, group projects, multimedia presentations, and self-reflection, so this study not only assesses the theory's efficacy but also advances the development of a practical implementation model. Therefore, the study's empirical results can serve as fundamental references for reforming the Technical and Vocational Education and Training (TVET) curriculum to better emphasise 21st century capabilities, especially in terms of enhancing students' preparedness for the demands of the future industry. In general, it is anticipated that the use of this research will aid in the creation of a more dynamic and successful teaching model within the technical education setting. The study's conclusions should serve as a guide for developing an all-encompassing teaching approach and raise graduates' learning standards and competitiveness.

2. Literature Review

To improve the educational system for the twenty-first century, several parties have stressed the importance of students mastering 6C Skills. The development of soft and social skills is just as important to effective education in the twenty-first century as academic success (Abdullah et al., 2021). These competencies are particularly crucial in a complex and dynamic workplace (Niza Abdullah & Hassan, 2024). Thus, it is necessary to balance knowledge and application skills in the learning curriculum. The goal of teaching and learning should be to help students develop their overall competencies.

According to Mohd Shah and Kamaruddin (2022), students that participate in in-depth, contextual learning experiences achieve meaningful learning. They established the idea of "deep learning," which encompasses the 6Cs, or key competencies. This theory highlights a method of instruction that involves pupils in a process of cooperation, inquiry, and introspection (Sarker, 2021). In this context, learning encompasses both the acquisition of knowledge

and the application of that knowledge in practical contexts. Students must be inspired to tackle practical issues, communicate clearly, and make contributions to society.

Besides, Voon & Amran (2021) emphasised that instruction should allow for constructive and active learning. Approaches like project-based learning and authentic assessment are perfect for technical education because they let students directly develop the skills they need. When students actively participate in real-world problem-solving and practical activities, they will comprehend concepts more fully (Mohd Nasir & Lajium, 2024). Additionally, it helps pupils develop a professional attitude and high-level thinking abilities.

According to the study Rosli et al. (2023), children who participate in project-based learning exhibit gains in their capacity for creativity, teamwork, and classroom participation. Students can be able to think creatively and create unique goods through projects that are methodically planned (Forward & Forward, 2022). This is because they perceive the learning they are undergoing as genuine and relevant to their future needs, pupils are more motivated when using this strategy (Mohamed Jaafer Sadiq & Hassan, 2021). This method is therefore thought to be highly appropriate for teaching Skills 6C.

Nevertheless, there are currently few studies that explicitly evaluate the efficacy of 6C Skills exercises in technical courses in Malaysia. Most of the current research focusses more on the general education and school context. By concentrating on the application and effects of the 6C activities in the Industrial Design course, this study seeks to close the gap. It is anticipated that the results of this study will add to the body of knowledge in the area and offer factual data that will help educators and legislators create more pertinent curricula.

3. Method

The influence of 6C Skills-based activities on student performance and soft skill mastery in Industrial Design (RBI) courses was examined in this study using a quasi-experimental design. Participants included 93 instructors, 49 of whom were allocated to the Treatment Group (TG) and 44 to the Control Group (CG), and 92 Bachelor of Vocational Education (SMPV) students, 50 of whom were in the TG and 42 of whom were in the CG. Lecturers were purposefully and strategically included: CG lecturers taught traditional lessons without explicitly incorporating the 6C framework, while TG instructors received training on how to conduct structured 6C-based activities like creative design tasks, group projects, multimedia presentations, and reflective exercises. According to Memon et al. (2020), their function was essential in guaranteeing instructional fidelity and offering triangulated assessments of student performance, which are suggested to improve internal validity in educational research.

To assess the effectiveness of 6C Skills-based activities, two different but complimentary viewpoints were chosen as respondents: students and lecturers (Rosli, Basari, & Che Isa, 2023). As direct participants, students offer valuable insights into their personal development and perceived proficiency in creativity, critical thinking, and teamwork, while lecturers provide expert observations of behavioral shifts, engagement, and output quality during the intervention (Abdul Mutalib, Hassan, & Mohd Noor, 2023). A more legitimate, complex, and pedagogically significant knowledge of how 6C integration changes learning in technical education is ensured by the study's triangulation of both viewpoints (UJSSH, 2025). To gather information, two primary tools were employed. First, a rubric that prioritized creativity, problem-solving, teamwork, and applicability to industry standards was used to evaluate the final project results of the students. To assess students' self-perceived proficiency in six essential areas; creativity (C1), critical thinking (C2), communication (C3), collaboration (C4), character (C5), and citizenship (C6). 6C Skills Mastery Questionnaire was given both before and after the intervention (Munusamy and Gurusamy, 2023).

Several measures were implemented to guarantee the validity and dependability of these instruments. To ensure content validity and compliance with best practices established by Abdul Mutalib et al. (2023), the questionnaire was reviewed by three experts in TVET pedagogy and psychometrics. All the subscales scored above 0.85, suggesting strong reliability, and Cronbach's alpha analysis verified internal consistency. Using inter-rater reliability analysis, the project rubric was piloted and improved. It obtained a Cohen's kappa of 0.82, indicating significant agreement among assessors (Ahad et al., 2011).

Normality checks were performed using skewness and kurtosis values before inferential analysis. Some of the items, such the post-intervention score for Communication (C3TG), had skewness = -1.311 and kurtosis = 2.238, which were both over the permitted range of ±1 for skewness and ±3 for kurtosis. Non-parametric statistical tests, which are better suited for data that deviates from the normal distribution, were used because of these anomalies (Iba & Wardhana, 2024; Zulkipli et al., 2017). The Wilcoxon Signed-Rank test was therefore employed to evaluate within-group changes, and the Mann-Whitney U test was utilized to compare differences between TG and CG.

However, when applicable, the Kruskal-Wallis test was also used for multi-group comparisons. This methodological strategy was created to guarantee precision, thoroughness, and insightful analysis of the intervention's effects. Through the integration of instructor and student views and the validation of the used tools, the study offers a strong basis for comprehending how 6C-based pedagogy might improve the development of soft skills and cognitive abilities in technical education settings. A well-structured design enhances the validity of results and promotes empirically supported instructional innovation, as Creswell (2009) emphasized.

4. Data Analysis

Students in the treatment group (TG) demonstrated high levels of achievement in every subcomponent of Skill 6C competency. According to Mohd Majid (2005), a level of mastery that falls between 3.67 to 5.00 on the five-point Likert scale, where 1 represents strongly disagree and 5 represents strongly agree, is classified as high. Students' 6C subskill mastery scores were descriptively analysed, and Table 1 revealed significant differences between the treatment group (TG) and the control group (CG). In comparison to the control group, which did not undergo a particular intervention, the treatment group that underwent the Skill 6C-based intervention improved their pre-intervention stores across all subskills more consistently and more significantly overall.

In the creative subskill (C1), the treatment group's score increased by 3.23 points, whereas the control group's score decreased by 0.08 points. This demonstrates how a teaching strategy that promotes ideation and innovation-based project creation can inspire students' creativity. The treatment group recorded a gain of 2.84 on the critical thinking subskill (C2), whereas the control group remained nearly steady (a reduction of 0.05). This demonstrates how students' capacity for methodical, objective thought can be refined through activities that prioritise problem-solving and in-depth situation analysis. The control group saw a drop of 0.21 points in the communication sub-skills (C3), whereas the treatment group saw a rise of 2.20 points. This illustrates how successful group presentations and introspective conversations are when incorporated with interventions. Improvements in collaboration subskills (C4) were also noted in both groups, although they were more pronounced in TG (2.20) than in CG (0.19), suggesting that structured team-based learning and shared assignments have a greater influence.

TG students improved by 2.02 points in the character (C5) category, whereas CG students had an increase of 0.23 points. This demonstrates how treatments that provide children with a place to think about themselves and participate actively can help them develop qualities like ethics, responsibility, and self-confidence. Finally, there was a 2.24 increase in TG and a 0.39 drop in CG in the citizenship subskill (C6). These results demonstrate how successful it is to engage in civic values-based activities and technology use in a cooperative, moral setting.

Table 1. Descriptive Analysis of 6C Subskill Mastery Scores Among Treatment Group (TG) and Control Group (CG) Students

Subskills	TG Pre	TG Post	Δ TG	CG Pre	CG Post	Δ CG	Differences Between Groups
C1 (Creativity)	5.21	8.44	+3.23	5.24	5.16	-0.08	Very noticeable
C2 (Critical Thinking)	5.58	8.43	+2.84	5.57	5.52	-0.05	Very noticeable
C3 (Communication)	6.56	8.77	+2.20	6.56	6.34	-0.21	Significant
C4 (Collaboration)	6.32	8.52	+2.20	6.34	6.53	+0.19	Significant
C5 (Character)	6.44	8.47	+2.02	6.42	6.66	+0.23	Simple
C6 (Citizenship)	6.28	8.52	+2.24	6.22	5.82	-0.39	Very noticeable

preTG: mean score of the pre-treatment group test
postTG: mean score of post-treatment group test
pre-CG: mean score of the control group pre-test
postCG: mean score of the post-control group test

The analysis includes not only the student's proficiency with the 6Cs but also their project achievement score (total marks). The grade score range is as follows (UTHM Undergraduate Academic Handbook) according to the General Parking Guidelines of Universiti Tun Hussein Onn Malaysia (UTHM), which are displayed in Table 2. Students in the treatment group (TG) scored an average of 81.48%, according to the results, whereas students in the control group (CG) scored 76.88%. The UTHM Undergraduate Academic Handbook, Latest Edition states that results between 75 and 84 percent fall into the B+ category, which is equivalent to Excellent, according to the university's

official scoring system. While both groups received identical grades, the inference analysis revealed a statistically significant difference (Mann-Whitney U = 566.500, p <.001), demonstrating that the use of activities based on Skill 6C had a consistent and beneficial effect on students' achievement of work outcomes.

Table 2. The Grade Scoring Range Is as Follows (Ref: UTHM Undergraduate Academic Handbook)

Score (%)	Belief	Achievements
85–100	A	Brilliant
75–84	B+	Excellent
65–74	B	Good
50–64	C	Satisfactory
<50	F	Fail

4.1 Skill Mastery Inference Analysis 6C

Table 3. Analysis of Normality of Skewness and Kurtosis for CG and TG Students and Lecturers

	Students			Lecturer		
	S Mean	S Skewness	S Kurtosis	L Mean	L Skewness	L Kurtosis
TotalmarTG	81.48	-1.089	.137			
TotalmarCG	76.88	-.739	-.781			
C1TGPre	5.214	.384	1.105	4.814	-.332	.304
C1TGPost	8.446	-1.145	1.128	6.637	.185	-.830
C2TGPre	5.586	-.080	-.435	4.480	-.528	.053
C2TGPost	8.434	-.969	.666	6.745	.077	-.876
C3TGPre	6.568	-.348	-.455	4.551	.267	2.235
C3TGPost	8.770	-1.311	2.238	6.792	.122	-.945
C4TGPre	6.324	-.358	-.048	4.482	-.133	-1.021
C4TGPost	8.524	-1.348	1.909	6.824	.235	-.968
C5TGPre	6.448	-.489	.316	4.271	-.178	-.615
C5TGPost	8.474	-1.123	1.144	6.886	.297	-.866
C6TGPre	6.280	.052	-.456	4.394	-.279	-.434
C6TGPost	8.528	-1.011	.784	6.849	.180	-.950
C1CGPre	5.245	-.129	-.597	4.966	-.693	.387
C1CGPost	5.164	-.234	.442	5.048	-.584	.424
C2CGPre	5.579	-.117	.167	4.366	-.041	-1.043
C2CGPost	5.524	-.223	-.459	4.195	-.154	-.559
C3CGPre	6.562	-.208	-1.150	4.616	-.195	-1.060
C3CGPost	6.343	-.264	-.981	4.648	-.286	-.994
C4CGPre	6.340	-.498	.574	4.330	-.229	-1.262
C4CGPost	6.533	-.113	-.863	4.418	-.100	-1.157
C5CGPre	6.429	-1.111	-.968	4.275	.387	-.926
C5CGPost	6.660	-.202	-1.099	4.452	.244	-.832
C6CGPre	6.226	-.031	-.754	3.857	.148	-.901
C6CGPost	5.829	-.213	-.923	3.959	.010	-.967

Table 3 shows that normality tests based on skewness and kurtosis values revealed that some items were more than ±1, which suggests that the data distribution was aberrant. Skewness = -1.311 and kurtosis = 2.238, for instance, are beyond the level recommended by Iba & Wardhana (2024), which is ±1 for skewness and ±3 for kurtosis, in a student's post-C3TG score. The use of nonparametric tests like Wilcoxon Signed-Rank and Mann-Whitney U in follow-up analysis is supported by these anomalies (Zulkipli et al., 2017). These results are also consistent with the reality of social studies, which involves students' perspectives and exhibits aberrant distributions in data (Azmi et al.,

2022). Therefore, the non-parametric statistics used are appropriate and legitimate for assessing the study's hypothesis. In general, this normality analysis serves as a crucial foundation for guaranteeing the precision and reliability of the interpretation of the findings of the statistical tests that were employed (Ahad et al., 2011).

4.1.1 Hypothesis 1

Ho1: There is no significant difference in the achievement of project outcomes between CG and TG for SMPV, FPTV students

The results of the Mann-Whitney test indicate that the control group (CG) and the treatment group (TG) achieved significantly different project outcomes (U = 566.500, Z = -3.848, p <.001), as shown in Table 4. This demonstrates how using activities based on Skill 6C improves students' performance in Industrial Design classes. It is thought that interventions that highlight qualities like creativity, teamwork, and critical thinking improve students' educational experiences and productivity (Abd Aziz et al., 2025). Active learning strategies like project-based learning have been demonstrated to enhance both cognitive and practical accomplishment in technical and vocational education (Che Isa & Azid, 2021; Wan Rashid et al., 2020). These outcomes are consistent with those of Hawa et al. (2024) and Rosli et al. (2023), who discovered that a structured strategy based on 6C can boost the generation of unique and genuine items. Therefore, these findings lend credence to the necessity of implementing 21st century teaching approaches in skills-oriented courses in a methodical manner.

Table 4. Non-parametric Test for Achievement of Project Outcomes between CG and TG Students

Test Statistics[a]	
	Total Marks
Mann-Whitney U	566.500
Wilcoxon W	1469.500
Z	-3.848
Asymp. Sig. (2-tailed)	.000
a. Grouping Variable: Kump	

4.1.2 Hypothesis 2

Ho2i: There is no significant difference in the perception of pre-mastery of 6C between CG and TG among SMPV, FPTV students

The pre-Skill 6C scores of the students in the treatment group (TG) and the control group (CG) were compared using the Mann-Whitney U test (Table 5). No subcomponent of Skill 6C, including C1 creativity (U = 1014.00, Z = -0.283, p =.777), C2 critical thinking (U = 1030.50, Z = -0.153, p =.878), C3 communication (U = 1021.50, Z = -0.224, p =.823), C4 collaboration (U = 1040.00, Z = -0.079, p =.937), C5 character (U = 1035.50, Z = -0.114, p =.909), and C6 citizenship (U = 1032.50, z = -0.137, p =.891) were found to be significantly different. There is no statistically significant difference, as indicated by the p-value for each component being higher than .05. These results verify that prior to the intervention, the two groups' starting levels of proficiency in Skill 6C were equal. As a result, any modifications following the intervention can be ascribed to the 6C activity's efficacy rather than to underlying group differences.

Table 5. Non-parametric Test of Pre-Mastery Perception of 6C between CG and TG among SMPV, FPTV Students

	C1Pra	**C2Pra**	**C3Pra**	**C4Pra**	**C5Pra**	**C6Pra**
Mann-Whitney U	1014.00	1030.50	1021.50	1040.00	1035.50	1032.50
Wilcoxon W	2289.00	2305.50	2296.50	2315.00	1938.50	1935.50
Z	-.283	-.153	-.224	-.079	-.114	-.137
Asymp. Sig. (2-tailed)	.777	.878	.823	.937	.909	.891

Ho2ii: There is no significant difference in the perception of pre-mastery of 6C between CG and TG among SMPV, FPTV lecturers

The difference between CG and TG's pre-Skill 6C scores was also evaluated for the lecturer group using the Mann-Whitney U test (Table 6). All of the subcomponents, C1 creativity (U = 960.50, Z = -0.907, p =.364), C2

critical thinking (U = 1023.00, Z = -0.424, p =.672), C3 communication (U = 1013.00, Z = -0.501, p =.617), C4 collaboration (U = 1016.00, Z = -0.478, p =.633), C5 character (U = 1055.50, Z = -0.173, p =.862), and C6 citizenship (U = 836.00, Z = -1.865, p =.062) showed no statistically significant differences. Because the p-value of C1-C6 is bigger than .05 and at a significant level, the null hypothesis is accepted. In summary, the lecturers' initial assessments of the two groups' levels of proficiency in Skill 6C were consistent. From an internal validity perspective, this strengthens the study design.

Table 6. Non-parametric Test of Pre-Mastery Perception of 6C between CG and TG among SMPV, FPTV Lecturers

	C1Pra	C2Pra	C3Pra	C4Pra	C5Pra	C6Pra
Mann-Whitney U	960.50	1023.00	1013.00	1016.00	1055.50	836.00
Wilcoxon W	2185.50	2013.00	2238.00	2006.00	2045.50	1826.00
Z	-.907	-.424	-.501	-.478	-.173	-1.865
Asymp. Sig. (2-tailed)	.364	.672	.617	.633	.862	.062

4.1.3 Hypothesis 3

Ho3i: There is no significant difference in the perception of 6C mastery post between CG and TG among SMPV, FPTV students

The Mann-Whitney U test results in Table 7 demonstrate that CG and TG have significantly different post-scores for Skills 6C across all student subcomponents. Critical thinking (U = 101.50, Z = -7,476, p <.001), communication (U = 127.00, Z = -7,252, p <.001), collaboration (U = 234.00, Z = -6,409, p <.001), character (U = 362.00, Z = -5,403, p <.001), creativity (U = 87.00, Z = -7,600, p <.001), and citizenship (U = 150.50, Z = -7,070, p <.001). Following the intervention, the treatment group's performance in Skill 6C significantly improved, as evidenced by all p-values being significantly below.05. This shows that pupils' overall skill mastery has improved because of the scheduled activities. According to this effect, student learning outcomes and the 6C-based educational method are positively correlated.

Table 7. Non-parametric Test on the Perception of 6C Mastery Post between CG and TG among SMPV, FPTV Students

	C1Pos	C2Pos	C3Pos	C4Pos	C5Pos	C6Pos
Mann-Whitney U	87.00	101.50	127.00	234.00	362.00	150.50
Wilcoxon W	990.00	1004.50	1030.00	1137.00	1265.00	1053.50
Z	-7.600	-7.476	-7.252	-6.409	-5.403	-7.070
Asymp. Sig. (2-tailed)	.000	.000	.000	.000	.000	.000

Ho3ii: There is no significant difference in the perception of the 6C mastery post between CG and TG among SMPV, FPTV lecturers

Table 8. Non-parametric Test on the Perception of 6C Mastery Post between CG and TG among SMPV, FPTV Lecturers

	C1Pos	C2Pos	C3Pos	C4Pos	C5Pos	C6Pos
Mann-Whitney U	342.50	135.50	295.00	247.50	221.00	119.00
Wilcoxon W	1332.50	1125.50	1285.00	1237.50	1211.00	1109.00
Z	-5.678	-7.281	-6.044	-6.412	-6.618	-7.417
Asymp. Sig. (2-tailed)	.000	.000	.000	.000	.000	.000

Significant differences were also found between the control and treatment groups in all subcomponents following 6C Skills, according to the findings of the Mann-Whitney U test among lecturers in Table 8, very significant differences were found in the following areas: creativity (U = 342.50, Z = -5.678, p <.001), critical thinking (U = 135.50, Z = -7.281, p <.001), communication (U = 295.00, Z = -6.044, p <.001), collaboration (U = 247.50, Z = -6.412, p <.001), character (U = 221.00, Z = -6.618, p <.001), and citizenship (U = 119.00, Z = -7.417, p <.001). After the 6C

activity was implemented, the lecturers' assessment of the students' performance in the treatment group was noticeably better than that of the control group. These results demonstrate that interventions are successful from both the standpoint of the students and the teachers. This enhances the validity of the study's findings from two evaluation perspectives.

4.1.4 Hypothesis 4

Ho4i: There is no significant difference in the perception of pre- and post-6C mastery CG among SMPV, FPTV students

The control group's judgement of their mastery of 6C skills was evaluated using the Wilcoxon Signed-Rank test before and after a typical class period (table 9). Character (Z = -2.222, p =.026) and nationality (Z = -3.191, p =.001) were the only subcomponents that showed significant differences, according to the findings; creativity (Z = -1.199, p =.230), critical thinking (Z = -0.909, p =.363), communication (Z = -1.888, p =.059), and collaboration (Z = -0.468, p =.640) did not, however. According to this, only a small percentage of 6C elements show progress following traditional instruction sessions. The p-value for communication (C3), however, is getting close to significance levels, indicating an unofficial increase that might be brought on by unstructured behaviours. Consequently, it is believed that the standard teaching methodology is insufficiently successful in promoting the general development of 6C skills. These results corroborate the idea that developing 21st-century abilities requires more than just content-based training.

Table 9. Perception of Pre and Post 6C Mastery CG among SMPV, FPTV Students

	C1Pos - C1Pra	C2Pos - C2Pra	C3Pos - C3Pra	C4Pos - C4Pra	C5Pos - C5Pra	C6Pos - C6Pra
Z	-1.199b	-.909b	-1.888b	-.468c	-2.222c	-3.191b
Asymp. Sig. (2-tailed)	.230	.363	.059	.640	.026	.001
a. Wilcoxon Signed Ranks Test						
b. Based on positive ranks.						
c. Based on negative ranks.						

Ho4ii: There is no significant difference in pre- and post-6C proficiency perceptions CG among SMPV, FPTV lecturers

According to table 10 of the Wilcoxon Signed-Rank test, only one subcomponent for the lecturer group, the character (Z = -2.624, p =.009), showed a significant change between pre and post. No significant differences were seen in other subcomponents, including creativity (Z = -1.447, p =.148), critical thinking (Z = -1.063, p =.288), communication (Z = -0.487, p =.626), cooperation (Z = -1.023, p =.306), and citizenship (Z = -1.185, p =.236). According to lecturers, this indicates that traditional instruction does not significantly enhance students' overall proficiency in the 6C Skills. The student's organic growth over the course of the semester, rather than direct assistance, is probably responsible for minor changes in character subcomponents. The conclusion that traditional methods are insufficient to promote competency improvement in the twenty-first century is generally supported by these findings.

Table 10. Non-parametric Tests on pre- and post-6C Proficiency Perceptions CG among SMPV, FPTV Lecturers

	C1Pos - C1Pra	C2Pos - C2Pra	C3Pos - C3Pra	C4Pos - C4Pra	C5Pos - C5Pra	C6Pos - C6Pra
Z	-1.447b	-1.063a	-.487b	-1.023b	-2.624b	-1.185b
Asymp. Sig. (2-tailed)	.148	.288	.626	.306	.009	.236
a. Wilcoxon Signed Ranks Test						
b. Based on negative ranks.						

4.1.5 Hypothesis 5

Ho5i: There is no significant difference in the perception of pre and post 6C mastery between TG among SMPV, FPTV students

All the treatment group students' subcomponents of 6C skills exhibited significant variations between pre and post, according to the Wilcoxon Signed-Rank test in Table 11. Critical thinking (Z = -5,996, p <.001), communication (Z = -5,866, p <.001), cooperation (Z = -5,533, p <.001), character (Z = -5,641, p <.001), and citizenship (Z = -5,684, p <.001) all saw significant increases in their scores, as did creativity (Z = -5,938, p <.001). The fact that all p-values were significantly below the significance level of .05 indicates that 6C-based interventions have been successful in raising the degree of proficiency in every skill. These interventions have a broad and consistent effect on a variety of technical and soft skill categories. These results are consistent with a literature analysis that makes the case for collaborative activities and project-based learning successful methods for developing complex abilities (Rosli et al., 2023; Mohamed Yusoff et al., 2024). In vocational instruction, this highlights the need of pedagogy based on the 6Cs.level.

Table 11. Non-parametric Test of pre- and post-6C Mastery Perception between TG among SMPV, FPTV Students

	C1Pos - C1Pra	C2Pos - C2Pra	C3Pos - C3Pra	C4Pos - C4Pra	C5Pos - C5Pra	C6Pos - C6Pra
Z	-5.938b	-5.996b	-5.866b	-5.533b	-5.641b	-5.684b
Asymp. Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
a. Wilcoxon Signed Ranks Test						
b. Based on negative ranks.						

Ho5ii: No significant difference in perception of pre- and post-6C proficiency between TG among SMPV, FPTV lecturers

Significant differences were also seen for each of the subcomponents of Skill 6C in the Wilcoxon Signed-Rank results for the lecturers in Table 12. Significant improvements were noted in the following areas from the perspective of the lecturer: creativity (Z = -5.815, p <.001), critical thinking (Z = -5.934, p <.001), communication (Z = -5.795, p <.001), collaboration (Z = -6.024, p <.001), character (Z = -6.070, p <.001), and citizenship (Z = -6.035, p <.001). This demonstrates the constant effects of interventions from the viewpoints of lecturers and students. The instructors' strong positive opinion of the intervention suggests that it is appropriate from the perspective of being implemented in the real classroom. In technical and vocational contexts, these results bolster the 6C approach's capacity to raise student accomplishment and teaching efficacy. All things considered, these treatments have demonstrated the ability to develop well-rounded skills in a methodical, effective, and long-lasting way.

Table 12. Non-parametric Tests on pre- and post-6C Proficiency Perceptions between TG among SMPV, FPTV Lecturers

	C1Pos - C1Pra	C2Pos - C2Pra	C3Pos - C3Pra	C4Pos - C4Pra	C5Pos - C5Pra	C6Pos - C6Pra
Z	-5.815b	-5.934b	-5.795b	-6.024b	-6.070b	-6.035b
Asymp.Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
a. Wilcoxon Signed Ranks Test						
b. Based on negative ranks.						

5. Discussion

The purpose of this study was to investigate if incorporating 6C Skills-based exercises into Industrial Design (RBI) courses may significantly improve students' academic performance and soft skills. To shed light on the wider implications for TVET practice and curriculum design, the discussion that follows is structured according to hypotheses and combines statistical results, pedagogical theory, and current empirical research. Considering Table 1, these findings align with study by Rosli et al. (2023) and Basari (2023), which asserted that teaching TVET students project-based learning and teamwork might enhance soft skills including cooperation, communication, and creativity. These results further support Mohd Shah and Kamaruddin's (2022) suggestion that technical education should place an emphasis on practical experience and authentic learning. The considerable difference in scores between the treatment and control groups shows how effective Skill 6C-based interventions are at enhancing students' social,

emotional, and cognitive abilities. In all 6C categories, the therapy group not only showed a general improvement, but the improvement was consistent and significant. Therefore, it is advised that the educational approach based on Skills 6C be fully implemented in technical courses like Industrial Design to create students who are more equipped to handle the difficulties of the 21st century.

Ho1: There is no significant difference in the achievement of project outcomes between CG and TG for SMPV, FPTV students

Ho1 was rejected, and a significant Mann-Whitney U result ($U = 566.500$, $p < .001$) confirmed that students who received 6C-based teaching did better on projects than their counterparts. Both groups received "Excellent" marks according to UTHM's rubric, but the TG's higher mean score (81.48% vs. 76.88%) indicates more than simply numerical supremacy; it also shows greater alignment with industry standards, deeper engagement with the design process, and more sophisticated problem-solving. This result is consistent with Forward and Forward (2022), who contend that when students are allowed the opportunity to brainstorm, work together, and reflect, their works become both technically sound and contextually significant. Students were co-constructing knowledge in the TG through iterative design, peer evaluation, and real-world relevance, rather than just finishing assignments. This is consistent with authentic learning principles, which hold that evaluation is a mirror of meaningful learning rather than an end goal (Karpudewan et al., 2023). In contrast, the CG's poorer success might be a result of traditional education's shortcomings in developing transferable skills. According to Venkatraman et al. (2022), delivering a lot of knowledge without providing organized chances for creativity and teamwork frequently results in superficial comprehension and disinterest. This has the obvious implication that technical proficiency is no longer enough. Graduates must be capable of collaborating across fields, navigating uncertainty, and making moral contributions to society.

Ho2i: There is no significant difference in the perception of pre-mastery of 6C between CG and TG among SMPV, FPTV students

The fact that both groups started the intervention with similar levels of self-perceived 6C competence is confirmed by the acceptance of Ho2i ($p > .05$ across all subskills). This eliminates pre-existing differences as a confounding factor, which is a crucial basis for internal validity. It also illustrates a more general reality regarding the condition of soft skills in technical education: despite their significance, these abilities are frequently underdeveloped unless specifically instructed (Rosli et al., 2023). It is interesting to note that, even though the students are enrolled in a university-level program, the baseline parity also raises the possibility that they may not have had any prior experience to systematic soft skills development. This is consistent with research by UJSSH (2025), which found that many TVET students had great technical skills when they start college but little background in civic-oriented, reflective, or collaborative learning. It is implied that soft skills need to be deliberately developed rather than taken for granted.

Ho2ii: There is no significant difference in the perception of pre-mastery of 6C between CG and TG among SMPV, FPTV lecturers

There were no appreciable variations in pre-intervention 6C mastery between lecturer and student perceptions (Table 6). This convergence is significant. It implies that teachers had the same idea of students' starting talents, independent of group projects. This kind of agreement demonstrates a common pedagogical perspective among the teachers and strengthens the findings' legitimacy. Furthermore, this outcome emphasizes how crucial it is to include instructors as co-researchers and evaluators in addition to content deliverers. Teachers who participate in reflective evaluation are more sensitive to the subtleties of students' development, especially in emotive domains that are more difficult to measure (Abdul Mutalib et al., 2023). The fairness of the intervention is further supported by this shared baseline, which guarantees that any increases were not the result of instructor bias or varying expectations.

Ho3i: There is no significant difference in the perception of 6C mastery post between CG and TG among SMPV, FPTV students

With substantial variations across all subskills ($p < .001$), the rejection of Ho3i offers strong evidence that the 6C-based intervention significantly changed students' perceptions of their own abilities. The skills that are frequently isolated or neglected in technical curricula; creativity, critical thinking, communication, teamwork, character, and citizenship, saw notable advances, according to TG. These improvements reflect a change in how students view themselves as learners and potential professionals, and they are more than just statistical artifacts. According to Rosli et al. (2023), studentds start internalizing the traits of lifelong learners when they work on intellectually challenging and socially significant tasks. For example, the TG's increase in Character (+2.02) and Citizenship (+2.24) indicates that the intervention promoted not just the development of skills but also civic duty and ethical consciousness. This is

especially noteworthy when considering Malaysia's national education objectives, which prioritize graduates who are values-driven, holistic, and capable of advancing social and economic growth (The Asia Foundation, 2024). The results confirm that soft skills are essential to TVET's purpose and are not negligible.

Ho3ii: There is no significant difference in the perception of 6C mastery post between CG and TG among SMPV, FPTV lecturers

Following the 6C-based intervention, instructors saw considerable increases in student competence, as evidenced by the rejection of Ho3ii based on significant differences in post-intervention lecturer evaluations across all 6C subskills ($p < .001$). The findings are more credible because of the correlation between lecturer evaluation (Ho3ii) and student self-perception (Ho3i), which implies that the intervention had noticeable, palpable impacts on classroom operations. Higher command of the three areas of creativity, communication, and citizenship, skills that are sometimes overlooked in technical education was reported by lecturers in the TG. This illustrates how structured activities that promoted idea sharing, moral teamwork, and engagement with civic issues like multimedia presentations, group design projects, and reflective journaling have influenced students. Abdul Mutalib et al. (2023) point out that when teachers engage in reflective observation and formative assessment, they become important observers of students' changes in mentality as well as output. This perceptional convergence also implies that the intervention promoted a common language of instruction amongst instructors and students. For both sides to identify and express growth in 21st-century skills, it transcended content delivery and entered a co-construction area. Maintaining innovation in TVET settings requires this kind of instructional coherence (Rosli et al., 2023).

Ho4i: There is no significant difference in the perception of 6C mastery pre and post among TG students

TG students showed statistically substantial improvements in all 6C subskills following the intervention, as evidenced by the rejection of Ho4i and the Wilcoxon Signed-Rank test findings (Z values ranging from -5.533 to -5.996, $p < .001$). This conclusion is crucial, not just expected. The intervention's pedagogical design, which purposefully incorporated creativity, teamwork, and ethical reasoning into each learning exercise, is validated by this. The greatest improvements were shown in the areas of creativity and citizenship, indicating that students were not only thinking differently but also feeling differently about their responsibilities as contributors and learners. These changes demonstrate the effectiveness of genuine learning settings, which provide students the freedom to solve real-world problems, consider their values, and interact with their communities (Karpudewan et al., 2023). Crucially, cognitive domains were not the only areas where growth occurred. Additionally, students' character and communication improved, showing that they gained expressive confidence and interpersonal maturity qualities that are frequently disregarded in technical education. This backs up HRMARS's (2025) contention that soft skills should not be taken for granted as the result of technical training but rather must be developed through deliberate, scaffolded experiences.

Ho4ii: There is no significant difference in the perception of 6C mastery pre and post among TG lecturers

Ho4ii was rejected since TG lecturers also saw notable gains in students' knowledge of all 6C subskills after the intervention. This result supports the previous conclusion that the intervention was successful from the students' point of view and that it was also supported by seasoned teachers who witnessed the change for themselves. The lecturers' assessment of development in areas like Critical Thinking and Collaboration shows that students were engaging more deeply with complex tasks and working more successfully in teams. These are precisely the qualities that businesses need in modern technology experts (The Asia Foundation, 2024). A layer of credibility is added to the data by the fact that teachers, who frequently evaluate students based on performance, behavior, and interaction, observed these gains. Furthermore, it is probable that the lecturers' reflections are a result of their personal participation in the intervention. By supporting 6C-based activities, individuals actively participated in the pedagogical transition rather than acting as passive onlookers. The results of UJSSH (2025), which highlight the importance of teacher agency and professional development in maintaining innovation in TVET, are consistent with this.

Ho5i: There is no significant difference in the perception of 6C mastery post between CG and TG among SMPV, FPTV students

With notable variations in post-intervention ratings between TG and CG students ($p < .001$), the rejection of Ho5i demonstrates that the 6C-based strategy yielded better results in the development of soft skills. This discovery is especially significant because it separates the intervention's effect from other factors. Even though their baselines were comparable (Ho2i), TG students had significantly greater mastery of all six subskills by the end of the study. This outcome highlights how structured, skills-integrated pedagogy can have a transformative effect. It demonstrates

how children develop both intellectually and personally when they are given the chance to practice creative thinking, meaningful collaboration, and ethical reflection. Such expansion, according to Rosli et al. (2023) and Varona et al. (2024), is necessary to prepare graduates who can succeed in dynamic, diverse settings. The limitations of traditional training are further highlighted by the CG's stagnation or deterioration in several subskills, including as citizenship and communication. Even competent pupils may not develop their soft skills if they are not purposefully scaffolded. The necessity of curriculum reform that incorporates the 6C abilities as essential learning outcomes rather than elective extras is further supported by this.

Ho5ii: There is no significant difference in the perception of 6C mastery post between CG and TG among SMPV, FPTV lecturers

Ho5ii's rejection demonstrates that TG lecturers demonstrated noticeably greater post-intervention expertise than their CG peers. The triangulation of evidence is completed by this finding: the data demonstrated the difference, the lecturers observed the difference, and the students felt the difference. The ramifications are significant. A change in the learning culture itself is indicated when educators and students alike see improvements in ethics, creativity, and teamwork. It implies that the classroom is now a place of active, human-centered growth rather than a place of passive instruction. Such settings are crucial for producing graduates who are not only technically proficient but also socially conscious and emotionally intelligent, as noted by Venkatraman et al. (2022). This hypothesis supports the main idea of the study: 6C Skills-based pedagogy is transformative, not merely effective. In an ever-evolving world, it gives students the skills they need to lead with integrity, handle complexity, and make important contributions.

6. Conclusion

This study aimed to address three main research questions: do students and instructors perceive changes in 6C mastery before and after the intervention, and do these perceptions differ significantly between treatment and control groups? Do 6C Skills-based activities improve student project outcomes in Industrial Design courses? The results offer precise, fact-based responses, confirming that incorporating 6C pedagogy boosts academic achievement and soft skill development. In addition to demonstrating significant increases in all six 6C subskills, students in the treatment group also received higher project ratings. These gains were confirmed by both lecturer and self evaluation. Pre-intervention group validated the design's internal validity, while post-intervention triangulation reaffirmed the transformational power of collaborative, organized, and reflective learning. According to these findings, 6C-based training represents a fundamental change in technical education rather than an add-on. It equips students with the critical thinking, ethical collaboration, and significant contribution skills needed to meet the needs of the future workforce. The study provides a reproducible model for reforming TVET curricula, where graduates are empowered as not only technicians but also as responsible, innovative, and future-ready professionals with soft skills integrated as primary learning objectives.

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