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Learning motivation and psychological empowerment of socioeconomically disadvantaged learners – an empirical study on inclusive project-based learning during Covid-19

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ABSTRACT

Extending the theoretical frameworks of empowerment, design thinking, and Biggs' Presage-Process-Product (3P) model to multidisciplinary inclusive education, this study examines the relationship between the learning outcomes of inclusive project-based learning (PBL) and its impact on young learners' psychological empowerment (PE), learning motivation (LE) and sense of alienation (AL). Quantitative research results demonstrate that participatory PBL can contribute to inclusive education and empower the socioeconomic disadvantaged community in the process. The target group – young learners aged 6–12 years old living in sub-divided flats – perceived their learning more positively and showed a reduced sense of psychological alienation after the engagement in participatory design on their home learning environment. Ninety per cent of participants agreed that the participatory programme has improved the living and learning environment; 87.8% of them assented that their overall efficiency of studying and learning has improved. The findings confirmed that participatory design experiences have significant positive impacts on participants' PE and LE, whilst alleviating AL. This research adds knowledge to literature related to holistic competency development, PBL, and design thinking in inclusive education.

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inclusive education; project-
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psychological
empowerment; community
engagement

Introduction – learners' motivation by participatory project-based learning

The suspension of schools during the Covid-19 pandemic has a tremendous impact on young learners' development. Its adverse impact is particularly profound on socioeconomically disadvantaged children as their living environments are generally less supportive on homeschooling (Bayrakdar and Guveli 2020; Rose et al. 2021). Underpinned by the notions of experiential learning and participatory design for social inclusion (Björvinsson, Ehn, and Hillgren 2012; Sanders 2002), this paper

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focuses on a community inclusive project-based learning (PBL) programme co-operated by two tertiary education institutes in engaging young learners under compact living conditions in Hong Kong's sub-divided units (SDU) in redesigning their home learning environment. While much of the learning motivation-related research focuses on learners' intrinsic motivation and performance (Lam, Cheng, and Ma 2008; Hendijani et al. 2016; Baars, Wijnia, and Paas 2017; Fischer, Malycha, and Schafmann 2019), this article sets itself apart by examining the motivation and learning enhancement of socioeconomically disadvantaged youth as a result of the participatory project. This paper outlines the design and implementation of the participatory PBL programme and presents the empirical findings from the questionnaire surveys and face-to-face interviews with the participants on the impact of inclusive co-design PBL on the learners' psychological empowerment (PE), learning motivation (LE) and sense of alienation (AL).

Theoretical framework on education models and inclusive education

In view of the global discussion on the inclusive education paradigm, educational institutes and schools around the world have reviewed their pedagogical development on the holistic development of youths and students (Chan and Luk 2022; Shek and Sun 2009). The Organisation for Economic Co-operation and Development (OECD) launched the Future of Education and Skills 2030 project in 2015 to identify key components of the holistic competencies that are indispensable in the education for future (OECD 2019). Aside from building knowledge, skills and attitudes, inclusive education calls for an integrated approach in a wider spectrum to include the marginalised cohorts in the development of transformative competencies through action and reflection. Under this perspective, the interrelationships and collaborations among students, educators and communities become quintessential in shaping the future education ecology (Chan and Yeung 2020; Kaur and Arora 2014; Lynch and Irvine 2009; Messiou 2012). Literature on inquiry-based learning has recognised a pedagogical transformation to drive progressive education movement and inclusive education (Barron and Darling-Hammond 2008; Bell 2010; Larmer and Mergendoller 2010). Barr and Tagg's learner-centred paradigm (Barr and Tagg 1995) and POOL collaboration model (Fleischmann 2010) signify a paradigm shift based on the belief that learning ability is innate. Students, even at young ages, have the potential and capacities to define their learning goals, reflect on their decisions, and take responsible actions to bring about changes for the well-being of themselves and society. This practice is most explicit in the process of collaborative PBL where learners become active agents in the learning process by making their choices and decisions (Donnelly and Fitzmaurice 2005; Kemp 2013). Given the complexity, most PBL instances require students to work in groups to interact with community stakeholders outside of classroom settings (Krajcik and Blumenfeld 2005). Learning, as a social constructivist approach, is thus situated in the ecology of inclusive collaborations and interactions among students, peers, teachers, parents, and other community stakeholders. Through active engagement under the tenets of PBL and inclusive education, social cohesion is strengthened when students and community members challenge and solve ill-defined social problems together.

Extending Biggs' (1989) 3P framework on learning on empathetic design thinking model

This paper expands Biggs' Presage-Process-Product (3P) model (Biggs 1989; Chan and Yeung 2020; Freeth and Reeves 2004) to calibrate the design and organisation of community participatory design activities to study the impact on young learners' self-directedness, empowerment and holistic competency development. The adapted Biggs' 3P model is presented in Figure 1. Participatory design or co-design broadly refers to the consensual decision-making via various stakeholders' participation in the design of the object concerned (Sanoff 2020). Participatory design project stands itself apart from other PBL as it provides opportunities for learners to practise empathy in the process by incorporating the voices of end-users into every stage of the design cycle. It accentuates the collaborative efforts of participants to bring about changes by implementing their materialised learning outcomes in a real context. Students are empowered in the inclusive process where they gain new knowledge from others and develop holistic competencies from experiential learning such as reflection, communication and critical thinking (Chan and Yeung 2020).

In this paper, there is a concerted effort in integrating the established experiential learning models with a participatory design approach to open a new pluralistic dimension of knowledge construction (Bosman, Hammoud, and Arumugam 2019; Dong, Qin, and Chen 2014). By applying the five-stage design thinking framework to scaffold the learning activities, participatory PBL helps a community to build its capacity to develop creative solutions to intricate social problems. Through the process, the powerless are empowered as they are enabled to exert control over their immediate environments and communities. This process is best explained by Zimmerman's empowerment theory (Zimmerman 1990). In his model, empowerment is undertaken by providing the disadvantaged with the chance and support to acquire new skills and has a genuine influence on the decision-making while cultivating a sense of ownership of the project and developing mutually beneficial interactions with others (Perkins and

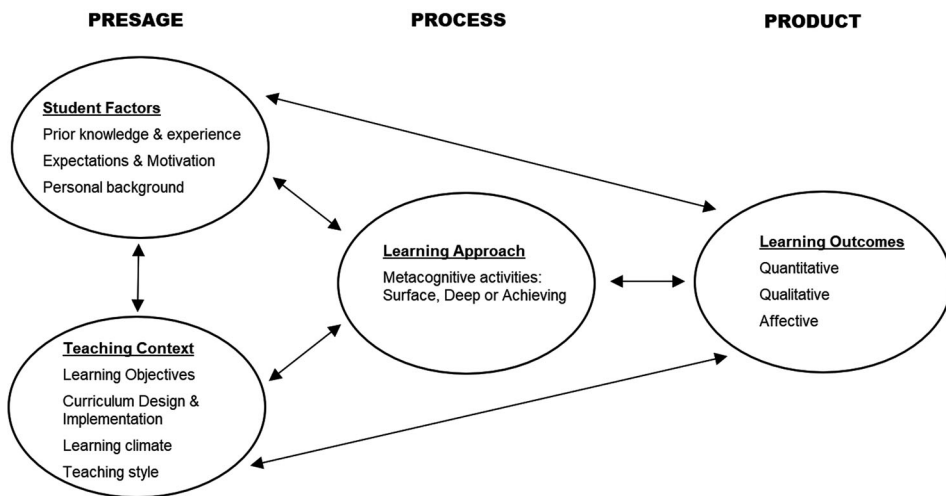


Figure 1. Biggs' 3P Model of Teaching and Learning. (Graph by author, Adapted from Biggs 1989)

Zimmerman 1995; Rappaport 1987; Zimmerman 1995, 2000; Zimmerman and Rappaport 1988). By utilising empowerment as a multilevel construct to processes and outcomes (Rappaport 1987; Swift and Levin 1987; Zimmerman 1995, 2000), this research builds a participatory PBL by engaging the economically disadvantaged citizens of a culturally reserved community to rethink their living environment and regain control of their immediate environment. As a result, the marginalised are empowered by acquiring new knowledge and effecting change as independent decision-makers.

Project-based learning in an inclusive design paradigm

There is a growing literature on the development of inclusive education that is conceptualised by participatory design (Borges et al. 2016; Holt, Moore, and Beckett 2014; Luck 2003) with flourishing examples of engaging children in co-creation (Keays and Huemann 2017; Merter and Hasirci 2018; Sutton and Kemp 2002; Walsh, Donahue, and Pease 2016). Although ideologies of social inclusion are well established, designing with children remains challenging as there is no definitive approach to ensure meaningful participation amongst children of different ages, competencies and cultures (Rigolon 2011). Theoretical models such as the ‘participation ladder’ (Hart 1992) and ‘categorization of children’s role in design’ (Druin 2002) have identified descriptive frameworks on the role of children in participatory design. Nevertheless, it has also been criticised that there is a research gap in the understanding of techniques, processes and methodologies which could enable the optimal level of children’s participation across different cultures (Ahn and Kim 2020; Hussain 2010; Venninen and Leinonen 2013). These challenges are prevalent in the engagement of Asian children in participatory activities as they are found to be more reserved in voicing concerns and less proactive to engage in educational dialogues (Ku and Kwok 2008). Asian children tend to be more conflict-avoidant and more passive in participation (Hussain 2010), which may be due to the collectivist cultural settings and parenting style in Asian families (Molitor and Hsu 2019; Shek and Chan 1999; Yip 2004). In contrast to Western societies, inherent conservative cultural attitudes in Asian cultures may cause additional challenges in co-designing inclusive activities. Since inclusive education is still a largely under-researched area in the Asian region, it becomes the impetus of this research to examine the impact of participatory PBL on the marginalised learners engaged in an Asian context.

Background – the vile living environment of sub-divided flats in Hong Kong

This participatory PBL programme centred around the driving question of how to improve the learning environment of children living in sub-divided units (SDUs) in Hong Kong. There are about 209,700 people of Hong Kong’s 7.4 million citizens living in extremely small SDUs with an average area per capita of around 5.7 square metres (Census and Statistics Department 2016). These dwellings are mostly privately-owned domestic quarters sub-divided into multiple small units for rental purposes (Huang 2017). Though overcrowded with substandard safety provisions, these SDUs have become the only financially feasible residence for many underprivileged families, who cannot afford private housing and are ineligible for public housing (Dwan, Wong, and Sawicki 2013; Leung and Yiu 2019).

The poor living conditions of SDUs pose an acute challenge to school-aged children. They often lack the necessary interior space for learning and other developmental activities which are essential to their growth (Figure 2). The immensely crowded living space has a serious compromising effect on their quality of life, personal safety and health. Studies have identified the association of children's and early teenagers' health and psychological problems with adverse and crowded living environments (Choi et al. 2017; Eamon 2002; Gove, Hughes, and Galle 1979; Harker 2006; Ho et al. 2016; Lai, Lee, and Yu 2017; Murnane, Maynard, and Ohls 1981; Solari and Mare 2012). These physical and psychosocial effects could extend into adulthood and cast long-lasting influences on the overall welfare of the individual concerned (Eamon 2002; Leventhal and Newman 2010; Najman et al. 2010). The inferior living environment could further exacerbate intergenerational poverty as poor school performance and lower educational attainment crusade to a higher chance of unemployment and continual poverty in later stages of life (Darling-Hammond et al. 2020; Jensen 2013).

Methodology – design thinking and inclusive participation

By applying design thinking and participatory design precedents (Binder 2007; Binder and Brandt 2008), a one-year duration of inclusive design workshops (Figure 3) with 15 SDU families were organised by a cohort of design students from two higher education institutions to attain the following learning objectives:

- (1) Facilitate the exchange of ideas, knowledge and techniques between the participants and the community stakeholders;
- (2) Empower participants to transform their exploration in inclusive design from a passive end-user role to an active collaborator;
- (3) Encourage the underprivileged to gain stewardship over their immediate learning environment;



Figure 2. The interior learning environment of a typical SDU in Hong Kong. (Photo by author)

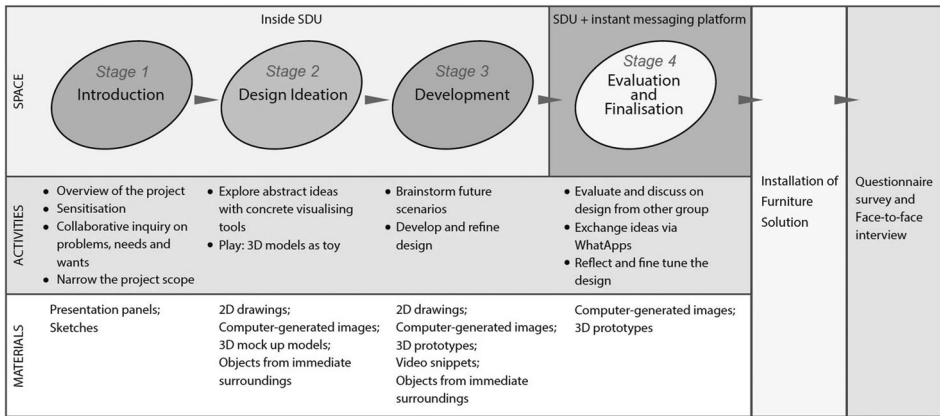


Figure 3. Programme design – Participatory design thinking as a methodology to achieve inclusiveness. (Graph by author)

(4) Enhance their learning motivation and promote a sense of ownership among this marginalised population.

The programme was designed as a four-stage mechanism for the interaction of co-design and co-learning to harness human-centred learning under the social dynamics. A multidisciplinary team was formed with design and architecture students from two higher education institutions, registered social workers, primary school teachers and private business sectors who later helped manufacture the physical furniture for the SDU residents. In this collaborative inquiry, the key participants were children and youth from age 6 to 12 with exasperated challenges in the learning environment due to Covid-19. They worked closely with the assigned social workers and designers to define their learning problems rooted in their specific SDU environment. Design toolkits were adapted as the inclusive design process unfolded in multiple stages.

Stage 1 – Understanding young learners' limitations and motivation in PBL

After multiple site visits which were both induction to ease anxiety and build trust among participants, the first stage targeted at understanding the limitations and aspirations of the young learners in the participation of the PBL. The team first presented graphic panels to engage participants to explore the interior configurations of each SDU and elicit reflections on their user experience. Participants partnered with team members into small groups to exchange their perspectives on directions for home improvement (Figure 4). The first stage revealed that school suspension due to Covid-19 had created an immediate urgency among participants to improve the environment for homeschooling. The scope of the project was clearly refined to focus on the design of a workstation as the research outcome – a bespoke study desk for each child for this critical period under the pandemic.

Stage 2 and 3 – Design ideation to enhance learners self-esteem

During the design ideation and development stages which spanned from June 2021 to Dec 2021, participants engaged in the design discussions on the dimensions, materials,



Figure 4. Perspective exchange among students and SDU participants to explore home improvement solutions. (Photo by author)

orientations, functions, and flexibility of their improvement to the learning environment. As part of the inquiry-based learning, the team brainstormed future scenarios together using statistical data on ergonomics and visual health, probed key questions with video snippets as well as interactively sketched out concepts to further explore specific learning limitations and goals of these SDU students.

At the early stage of the PBL, the team noticed that most of the SDU students had great difficulties in grasping ideas from verbal descriptions to sketch drawings. Most participants were reluctant to voice their concerns directly. By using 2D computer-generated drawings, 3D prototypes and scaled models as tools to facilitate design communication, the participating SDU students gradually became more outspoken in the workshops, some even actively suggested their preference for colours and materials. Interactive design thinking toolkits and non-intimidating design tools such as grocery carton boxes were used as mock-ups to illustrate ideas, spatial visualisation, and potential structural considerations in the design process. As an inclusive education tool, 3D models made from rapid-prototype technology were particularly useful in eliciting interactions with children. Participants engaged in the design process by actively reshaping, forming, tearing, and imagining. These activities enabled learning through play and facilitated participating young learners to express their preferences and test primitive solutions (Figure 5).

Stage 4 – Learning through empathy

Subsequent to multiple rounds of engagement in the course of a year, the team prepared presentations and shared the design concepts with the student participants and their families. They evaluated the design concepts together against established safety criteria and shared the motivation and rationale behind their design. This project stage focused on how to understand each other's points of view through empathy to revise the design before the final prototype production and testing. Compared to conventional methods of engagement, design thinking is recognised as a far more creative teaching and



Figure 5. Inclusive PBL scaffolded learning through play using 3D models as probes to examine learners' motivation. (Photo by author)

learning approach that prioritises observation, problem-framing, and hands-on prototyping (Kramsky 2017). While recognising that empathic design has many physical challenges in execution (Postma et al. 2012), a familiar home environment can be conducive to a productive participatory design process by using a user-centred approach to facilitate collaboration to generate design solutions (Vaajakallio and Mattelmäki 2007). Apart from the knowledge gained from direct observation of the lives of this marginalised community, the challenge of unfolding collaborative activities with multiple people (including tenants, design teams and social workers) in such a confined space fostered a unique empathy-building experience where the design team was truly immersed in the authentic living environment of the participants (Figure 6). Team members identified the spatial limitations, bad ergonomic posture, and poor lighting conditions from their immersion, and these concerns were put into consideration in the iterative design process.

Empirical study on PE, LM and AL

Further to the completion of the inclusive process (Figure 7), all participating SDU students and participants were asked to complete a questionnaire survey (Appendix) which contained specific questions to measure the three identified research parameters on the impact of participatory design, with a particular focus on learners' psychological empowerment (PE), learning motivation (LM) and their sense of alienation (AL).

As part of the mixed methodology, over 12 face-to-face interviews were also held to further study the programme impact. The qualitative reflections shared by these young SDU participants became part of the project assessment on inclusive education:

From 15-year-old student Sophie:

The participatory design process gave me a different experience in life. Before I was shy at school and was afraid that my classmates would know that I do my homework on my bed.



Figure 6. Building Empathy by immersing in a real context to learn about their learning difficulties, such as poor lighting, lack of space to develop inclusive design. (Photo by author)

Now, I have gained more self-esteem as I now feel equal with my peers in having a decent learning environment for Zoom meetings and online classes.

My performance at school has improved and I participate more and am proud to show my friends my nice desk that I was part of the design team to build it for myself ...

From another SDU student, Jacy, 12 years old:

The experience of participatory design was challenging during Covid but fun. Letting strangers in my house at first was scary but these people made my life better.

I can now have a good desk that belongs to me and not have to share with my brothers and I can put my homework on the shelf and can have proper light to see and read.

I can focus more and I like the process of participatory design, I think it is good that I was part of it ...

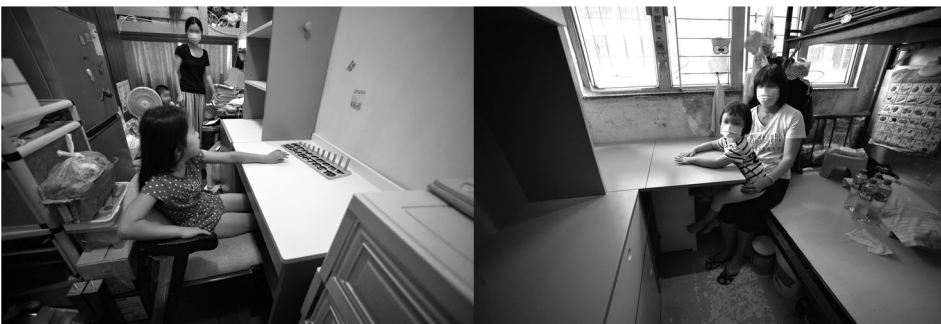


Figure 7. Implementation of the co-designed enhancement to the learning environment during the Covid-19 pandemic. (Photo by author)

From a participating school teacher who joined all of the workshops:

Covid-19 posed great difficulty for most students in their learning, and for those who are under poverty lines would have extra challenges due to the lack of proper environment for home learning. Despite social distancing and periodic closure of schools, it was fortunate these university students engaged the sub-divided flat children to improve their learning through workshops and play. The workshops with everyone were most useful to understand how to improve the learning environment and I observed the improvement in performance and self-esteem among my students.

Data analysis and research outcomes

A regression analysis was conducted on the responses of a total of 207 completed questionnaire surveys. The survey data analysis offered a perspective on the impact of participatory design on psychological empowerment (PE), learning motivation (LM) and sense of social alienation (AL). The research hypothesised that the participatory design process would have a direct positive effect on PE and LM, but a contrary negative impact on AL.

Ordinary least squares (OLS) regression is used to test the relationship (Figure 8), with participation as an independent variable; psychological empowerment (PE), learning motivation (LM) and alienation (AL) are the dependent variables. The generalised regression model is expressed as below:

- Participation, as the explanatory variable, is a dummy variable, taking the value of one if the person has participated in the participatory design project and the value of zero otherwise.
- PE_i (i = 1 ... 4) represents each aspect of psychological empowerment, including awareness of the personal impact, perceived competence, self-determination and perceived control.
- LM_i (i = 1 ... 3) is the quality of improved learning motivation, including not only willingness to learn, but also problem-solving skills and reduced anxiety towards the unknown.
- AL_i (i = 1 ... 3) stands for common characteristics of social alienation, including powerlessness, normlessness and uncontrollability.

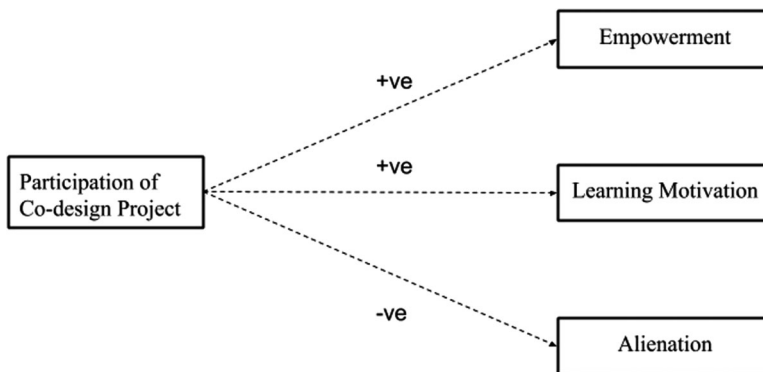


Figure 8. Expected impact of participatory design on learners' psychological empowerment (PE), learning motivation (LM) and alienation (AL). (Graph by author)

Values of all the above response variables are derived from the corresponding 5-point Likert scale survey questions (1 = strongly disagree to 5 = strongly agree). The higher scores indicate higher levels of each quality.

Data collection

Data are collected from two sets of samples, using paper and pencil questionnaire surveys. The first set of samples was composed of SDU children who directly participated in the participatory project ($N = 90$, refers as participants below). The second batch of samples ($N = 117$) consists of SDU residents, family members and participating teachers and social workers but have joined the programme and the participatory design workshops as indirect participants (refers as indirect participants below).

The purpose of this research was introduced to the respondents before the distribution of questionnaire surveys. The survey each took around 10 to 15 minutes to fill in. Respondents were given sufficient time to complete in a self-administrated manner. The questionnaire asked the respondents to evaluate if participation in inclusive design workshops brought changes to the three determined parameters related to learning outcomes – psychological empowerment, learning motivation and social alienation. Basic demographic characteristics and satisfaction levels of the indoor learning environment were also collected as the background information of the respondents.

Data and descriptive statistics

Survey respondents' demographic information

Questions on gender, age, and educational background were asked to give basic demographic information of both participants and indirect participants, as summarised in Table 1.

Gender. The genders of participants are evenly distributed. The sample of those who did not participate in this project is predominantly female, therefore overall there are more female respondents (71.5%) compared to males (28.5%).

Age. The respondents' age distribution spreads across a wide range, which goes from under 15 to above 55 years old. The majority groups are young and middle-aged respondents, with median age ranging from 18 to 45 years old, taking 61.8% of survey respondents.

Educational background. 79.22% of all respondents and 60% of participants have an educational level of secondary school and below. The largest group (32.2%) of participants have a primary school and below educational background, which is generally below the average educational attainment level of Hong Kong (Census and Statistics Department 2017).

The satisfaction level of the current living environment

As part of the goal to better understand how participatory design impacts their interior living condition during Covid-19, respondents were asked about their satisfaction levels of the living environment before and after the workshop. Indirect participants have been asked the same questions to provide their perspectives based on their observation on the improvement of learning attitude of the young learners. The results are shown in Table 2.

Table 1. Demographic information of survey respondents. (Table by author)

Attribute	Participants Frequency (N = 90)		Indirect participants Frequency (N = 117)		All Frequency (N = 207)	
		%		%		%
Gender						
Male	40	44.44	19	16.24	59	28.50
Female	50	55.56	98	83.76	148	71.50
Age						
Under 15	10	11.11	1	0.85	11	5.31
15–18	8	8.89	4	3.42	12	5.80
18–25	23	25.56	2	1.71	25	12.08
26–35	13	14.44	14	11.97	27	13.04
36–45	18	20	58	49.57	76	36.71
46–55	15	16.67	26	22.22	41	19.81
55+	3	3.33	12	10.26	15	7.25
Educational background						
Primary school and below	29	32.22	16	13.68	45	21.74
Secondary school	25	27.78	94	80.34	119	57.49
Diploma/Certificate	8	8.89	5	4.27	13	6.28
Sub-degree	7	7.78	0	0	7	3.38
Bachelor degree and above	21	23.33	2	1.71	23	11.11

80% of participants agreed that their daily lives were restrained by the small interior space in SDUs. Such belief was consistent between participants and indirect participants in the control group with similar housing situations and socio-economic backgrounds. After the participatory design project, 90% of participants agreed that their living environment, learning environment and life quality have been improved; 87.8% of them also agreed that their work and learning efficiency have been improved due to the interior learning environment improvement. It was analysed that after the interior space has been improved, the hours spent in the renovated SDU per day also increased, reflecting an increased willingness to stay in the space to undertake studying, self-learning and reading. 18.9% of the participants spent 0.5 to 1 hour more compared to their previous setting, and another 18.9% spent more than 1 hour extra in the area per day.

Descriptive statistics of explanatory and response variables

The descriptive statistics of explanatory and response variables for all the survey participants, combining both samples are presented in [Table 3](#).

Table 2. Satisfaction level of interior living environment before and after the participatory design project. (Table by author)

Questions	SA %	A %	Neutral %	DA %	SDA %*
Before the project					
Life is restrained by interior space.	25.56 (26.57)	54.44 (46.38)	11.11 (19.32)	8.89 (7.25)	0 (0.48)
After the project					
The living/learning environment has been improved.	16.67	73.33	5.55	3.33	1.11
Work/learning efficiency has been improved.	8.89	78.89	8.89	2.22	1.11
Life quality has improved.	16.67	73.33	5.55	3.33	1.11

Note: SA – Strongly agree, A – Agree, DA – Disagree, SDA – Strongly disagree.

*Percentage in the brackets represents answers from all the survey respondents (N = 207), including both direct and indirect participants in the inclusive design. The other figures are for participants only (N = 90).

Table 3. Descriptive statistics of explanatory and response variables ($N = 207$). (Table by author)

Attribute	Mean	SD	Range
Psychological Empowerment (PE)			
Awareness of impact	3.004831	1.058931	1–5
Perceived competence	3.086957	1.115719	1–5
Self-determination	3.280193	0.949575	1–5
Perceived control	3.246377	1.020267	1–5
Learning Motivation (LM)			
Willingness to learn	3.188406	0.979529	1–5
Problem-solving skills	3.246377	1.001055	1–5
Reduced anxiety towards unknown	3.260870	1.047218	1–5
Alienation (AL)			
Powerlessness	2.690821	0.960917	1–5
Normlessness	2.942029	1.100098	1–5
Uncontrollability	2.753623	1.020267	1–5
Participation			
Participant of project	0.434783	0.496930	0–1

Note: Values of each attribute correspond to the answers to certain survey questions, ranging from 1 to 5. The mapping can be found in the Appendix.

Data results

Table 4 shows the regression results of the generalised regression models for 207 survey respondents (90 participants, 117 indirect participants). F-statistic is significant at a 1% significance level in all the models for every attribute of interest, which rejects the null hypothesis and proves that participation in these participatory design workshops has an impact on psychological empowerment, learning motivation and alienation statistically.

Psychological Empowerment. Coefficients of participation in PE are positive. Among all the attributes, participants have the greatest improvement in the awareness of impact. They are more likely to realise that they can make changes to their current living and learning situation. The regression model has explained 43.3% of such variance, according to the adjusted R^2 value.

Learning Motivation. Similarly, participation has a positive impact on participants' learning motivation. They appear to be more willing to learn and show less anxiety towards new tasks, compared to those who did not join the workshops.

Table 4. Regression results of generalised models on each response variable. (Table by author)

Response variables	Coefficient	Std Error	Adjusted R^2	F-statistic
Psychological Empowerment (PE)				
Awareness of impact	1.406838***	0.111787	0.433104	158.3824
Perceived competence	1.418803***	0.121535	0.396394	136.2822
Self-determination	0.860684***	0.119158	0.198982	52.17282
Perceived control	0.979487***	0.126027	0.223826	60.40437
Learning Motivation (LM)				
Willingness to learn	0.924786***	0.121580	0.216305	57.85749
Problem-solving skills	0.782906***	0.129637	0.1469	36.47216
Reduced anxiety towards unknown	1.032479***	0.128310	0.23633	64.75011
Alienation (AL)				
Powerlessness	-0.927350***	0.118512	0.226233	61.22988
Normlessness	-1.352137***	0.122426	0.369994	121.9809
Uncontrollability	-0.979487***	0.126027	0.223826	60.40437

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Alienation. On the other hand, participation in the workshop helps to alleviate the feeling of social alienation. Coefficients towards every attribute of alienation are negative. Participants have reduced the pessimistic perceptions of themselves for being ordinary, powerless and unable to control their lives.

Discussion and conclusion

The regression results indicate that participation in this inclusive design has a positive impact on psychological empowerment and learning motivation, and a negative impact on alienation. The models show substantial correlation at a 1% significance level. The adjusted R^2 values are relatively low, suggesting that the independent variable, i.e. participation in this participatory design does not fully explain the variance of response variables. This is acceptable for this study since a young learner's psychological empowerment, learning motivation and social alienation can be affected and mediated by many other factors which are out of the scope of this study. The control group was also kept to a similar size ($N = 117$). Given that the focus is to determine the impact of participatory design on learners' motivation and it is the only explanatory variable in the regression models, the sample size is adequate to provide valid and meaningful results (Cowles 1974; Julious 2005).

Moreover, it is observed that the results for every aspect (PE, LM and AL) are consistent, which may be contributed by the fact that these variables are highly correlated among themselves in nature. For example, a person with stronger empowerment tends to have less social alienation, stronger motivation to learn, and more confidence to navigate through difficulties. Last, this study provides empirical evidence that participatory design experience can bring about impact on the three parameters of concern (PE, LM and AL) among the underprivileged students. However, a question naturally arises about the necessary link between participatory design, PBL and learners' psychological empowerment – whether the impact has resulted from participating in the process itself or from the material outcomes produced through it. This question is especially tricky if we take a closer look at their intertwined relation as the existence (or coming-into-being) of the artefact constitutes the intrinsic part of the process of its creation – it reflects the very experience of the creation process, including the inspiration, endeavour, and expectation of its creator. The topic is out of the scope of this study in consideration of its methodologies and design, and further discussion and investigation should be conducted to add knowledge to the matter.

This research is most timely in this Covid-19 period where home learning has become the new normal. Although some design scholars have criticised the tokenism of some participatory design projects that fall short before the implementation stage (Hart 1992; Lee 2008), this paper illustrates how a holistic inclusive design approach that embraces design thinking in a PBL can facilitate meaningful learning outcomes to an urgent social problem. The research provides a clearly defined mixed methodology to actualise participatory PBL projects in higher education and sets itself apart from other design education literature by combining multi-staged interventions with the physical implementation in a real-life context, engaging higher education in PBL, supporting with statistical analysis on the research outcome. In conclusion, the study contributes academically from both quantitative and qualitative perspectives on how participatory

design impacts youth's learning developmental attributes in inclusive education. The result offers a deeper understanding of how economically challenged families, who might suffer from social stigma and low socioeconomic status, could be empowered to enhance their learning attitude and other aspects of personal development such as holistic competency. Despite difficulties in running community engagement during the Covid-19 pandemic, such as closures on community centres and social distancing, this PBL format can be propagated into other inclusive education to bring design theory and practice together that can help students to build more inclusive awareness and social innovation.

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Appendix

Response variables and survey questions mapping for regression models

Response variables	Survey questions
<i>Psychological Empowerment (PE)</i>	
Awareness of impact	I feel I am able to make a change to my current situation.
Perceived competence	I know that I am able to accomplish something that might look difficult.
Self-determination	I feel confident in handling new tasks.
Perceived control	I feel I take more control of my life.
<i>Learning Motivation (LM)</i>	
Willingness to learn	I feel I am more willing to learn new things.
Problem-solving skills	I know I can use my knowledge to resolve problems.
Reduced anxiety towards unknown	I know I can learn to do something that I was not familiar with.
<i>Alienation (AL)</i>	
Powerlessness	I often feel nothing I could do to change my current situation.
Normlessness	I often feel it is hard to make accomplishments in life.
Uncontrollability	I often feel I don't have control of my life.