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Activating First-Year Engineering Students' Conation to Learn

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Abstract

This study investigates whether first-year engineering students' conation has the potential to be activated after learning in an introductory engineering course which was designed to support students' learning through the implementation of Cooperative Problem-Based Learning, an inductive student-centered approach that utilized authentic problems. A pre-and post-test instrument using Goal Orientation Index (GOI) was administered to thirty first-year engineering students taking an introduction to engineering course. The GOI has 96-items of 5-ordered-categories questionnaire consisting of three primary constructs of striving behavior in conation: Plan, Act, and Reflect. The GOI was analysed using Rasch measurement model to evaluate instruments' measurement functioning through investigating items' reliability coefficient, separation, fit statistics, unidimensionality, and person-item distribution map (PIDM). The pre- and post-data were analysed using SPSS which includes descriptive statistics to obtain the mean and standard deviation, and inferential statistics to investigate the significant difference in students' conation. The Rasch analysis shows that all items in the GOI instrument were reliable and valid to be used for statistical analysis. The reliability of the items and person has exceeded 0.70 and 1.5 respectively which is considered acceptable to be used and no modification to the item should be made. The separation indices for items and persons also have met the acceptable level of separation indices. The inferential statistics using a paired-sample t-test showed that there is no significant statistical difference in students' conation at pre-and post-test as the p-value exceeds 0.05. However, the results of the descriptive statistics, all sub-constructs show activation in conation as the mean values of the post-test is higher than the pre-test. This is also supported by the PIDM which clarifies that students agreed to various items at post-test. The results show that providing support at the tertiary level, specifically in a supportive learning environment, has the potential to activate students' conation.

Introduction

Studies on the faculties of the human mind, cognitive and affective domains are continually growing and attract the interest of many researchers. An often-overlooked domain in human mind is called conation, which focuses on the individual's inner talent, will, drive, determination, and perseverance to learn [1],[2]. The conative domain has been ignored for many years, as it is often intertwined with the cognitive (knowing) and affective (feeling) domains [1],[2]. Defined as the conscious drive to perform the volitional act that encourages an individual to strive towards attaining the goals, conation is very important as it describes how a person naturally approach a challenging situation [1],[3].

Human beings are born with conative talent. Depending on their life experiences, conation may be diminished once they grow up. While learning, students will engage or disengage their will to learn based on their perception of how important or rational the task is [2]. They will put as much effort they want if they think it is worth their time and effort. Educators can teach students the knowledge; however, none can externally make them learn [2]. It depends on students' intention whether they are willing to put effort and drive towards getting the knowledge. However, educators can still activate conation through supportive teaching and learning environment using an authentic or active learning in the classroom [2],[4]. It is important for educators to design a supportive learning environment in engineering courses that could help to nurture and foster students' conation [2],[4].

This study aims to investigate whether implementing a supportive learning environment in an introductory engineering course could activate first year students' conation to learn. This study was carried out on first year engineering students taking an Introduction to Engineering (ITE) course. Students' conation was assessed at pre- and post-test using an established instrument, the goal orientation index (GOI) and the results were then analysed using SPSS and Rasch analysis to investigate the potential of students' conation activation after learning in a supportive learning environment in ITE course. The ITE course implemented Cooperative Learning and Cooperative Problem-Based Learning to guide students to construct their understanding and professional skills to discover engineering and develop the skills to learn engineering.

Problem Background

One of the main challenges in engineering education in a fast-changing world entering the era of Industry 4.0 today is to attract students to be interested in engineering [5]. Current requirements on professional skills, coupled with difficult and complex engineering content demands that students' conation be activated in engineering courses, which helps them to have the ability to focus and maintain persistent effort to achieve productive competence in problem-solving situation [6]. Students who use conation to solve a problem, can perform more effectively by using their natural approaches rather that against them [7]. Instilling the importance of conation will help students to build confidence and enhance individual strength to retained and succeed in learning engineering [7]. Thus, it is important for engineering educators to be aware of conation to motivate students to put effort to learn.

To activate conation, students must be guided from the first year since it is the most crucial time where real struggle often takes place. Students must be active and possess the "staying power" on intrinsic motivational ability. Not every student has this capability to strive on their own. Therefore, it is important for educators to activate students' conation through the implementation of a supportive learning environment [8]. Supportive learning environment is the most important factor that could affect student's success in a classroom [9]. Therefore, first-year engineering programs should provide extensive academic and social support to activate students' conation to succeed academically in the university [10],[11], amongst them through the implementation of an introductory engineering course [12]. However, what kind of learning environment should educators design and implement to activate students' conation?

Introductory engineering courses have been introduced all around the world to provide support in different aspects such as enhancing students' motivation and introducing them to engineering fields professions [12]. In this study, the Introduction to Engineering (ITE) course utilized an authentic learning environment using cooperative problem-based learning (CPBL) to support first-year students to prepare them for the understanding and skills needed to learn engineering [13],[14]. The course introduces students to engineering and encourages them to stay in the field by revealing their potential through solving a semester-long sustainable development-related problem [14]. The course helps to bridge the gap between learning in school and university and cultivates the attributes of future engineers [13],[14]. The 3-credit hour course aims to enhance students' learning and improve their will and motivation to become self-directed learners that will support them to face the coming semesters. Although an earlier exploratory study on the course had shown that students were able to develop professional skills [13],[14], there were still questions if the teaching and learning approach implemented in the course could activate students' conation, especially among the current generation-Z. Answering this question will also provide engineering academics with an approach to activate conation among students in a typical classroom.

Overview in Conation

Besides the affective and cognitive domains, the conative domain, which is a domain of behaviours associated with striving, is one of the essential pieces in the human mind model on learning. According to American Heritage Dictionary of English Language [15],[16], conation is defined as mental processes that direct behavior and/or action, including impulse, desire, volition, and striving [1], [16]. McDougall stated that conation is how we strive, endeavour, pay attention, focus, work hard, exert ourselves, or do our utmost to complete an action [15],[17]. Conation underlies the act of striving to perform at the highest levels [15], where an individual is inclined to act purposefully [16]. Assagioli [18] described conation as the will to complete an action, or a purposive action with a clear vision of achieving goals [16],[18]. Having aims in goal setting are essential for students to become more productive [17] as it has the potential to impact learning [19], leading to better academic performance [10]. Atman introduced five stages of conation taxonomy: perception, focus, engagement, involvement and transcendence as shown in Table 1 [1],[15]. The conative stages enable the individual to assess and examine their pattern of motivational behaviour and develop their skills towards becoming more active.

Table 1: Taxonomy of the conative domain Conative Stages

Conative Stages		Descriptions
1	Perception (PR)	The individual opens all forms of sensory and intuitive stimuli. The energy rate in this stage is low
2	Focus (FC)	The individual brings information to a clear relief and distinguishes it from the background. He/she set the goal
3	Engagement (EN)	The individual is now goal-focused. Begin to work with all information, raising questions
4	Involvement (IN)	The individual thoroughly engaged in considering information, energized and work vigorously for project completion
5	Transcendence (TR)	The individual immerses him/herself in the task so that the mind/body/task becomes one. Participating the task wholly, totally, without self-recrimination.

An individual with high conation is a "successful striver" [20],[21] that has strong will and traits such as determined, decisive, persistent, patient, organized, initiative, and energized to do task [21]. Striving is the act of a self-directed goal related to behavior that is expressed through action. To assess conation, Atman created a Goal Orientation Index (GOI) instrument, consisting of a sequence used to develop striving behavior (goal-directed), called the Conative Cycle [20],[21],[22]. The cycle was derived from the achievement motivation literature and incorporates three essential skills used in goal attainment: information management, energy mobilization, and time use control [22],[23],[24]. In the process of goal attainment, individuals utilize three constructs of striving behavior: reflecting, planning, and acting behaviors[22].

The Planning construct involves long- and short-term goals that direct action where students must be aware of what is happening around them [24]. Four behaviors in this construct are set goals (SG), recognize needs, problems, challenges, and opportunities (RP), purpose long-range direction (PU), and organize (OR) [21],[22],[24]. In the Acting construct, the individual engages in 'intentional achievement' – the conscious choice to focus on one's energy in a pre-determined direction [24]. Four behaviors in this construct are make it happen (MH), wrap it up (WU), push on (PO), and select strategy (SS) [21],[22],[24]. The Reflecting construct relates to thinking, such as visualizing how things will be, seeking options, and evaluating the problem. In this behavior, students assess possible risks and reflecting on future improvement [25]. Four behaviors in this construct are get your act in gear (visualize) (ACT), brainstorm alternatives (BR), ooo & ah! (evaluate) (OA) and assess risks (AR) [21],[24]. Figure 1 shows the Conative Cycle, consisting of twelve sub-constructs of striving behavior under act, plan, and reflect on achieving goals. [21],[22],[24]. Table 2 states twelve constructs of striving behavior interrelated with the five levels of conative taxonomy.

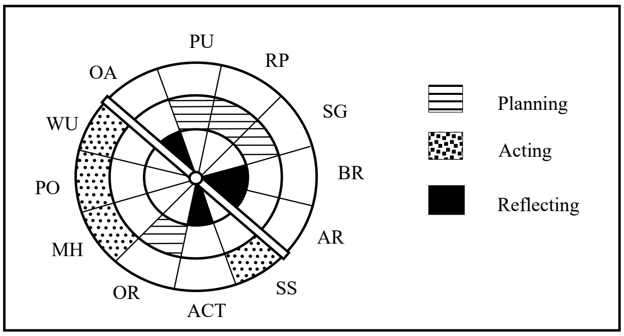

Figure 1: Conation Cycle adapted by Atman (1987)

Table 2: Steps in the Conation Cycle in Conative Taxonomy

Conative Taxonomy	Steps in the Conation Cycle (Atman 1986)	Striving behavior
Perception	Ooo & Ah! (Evaluate)	Reflect
	Purpose/Long Range Direction	Plan
	Recognize need, problem, challenge, opportunity	Plan
Focus	Set goal	Plan
Engagement	Organize	Plan
	Assess risks	Reflect
	Brainstorm alternatives	Reflect
	Get Your Act in Gear! (Visualize)	Reflect
	Select strategy	Act
Involvement	Make it happen	Act
Transcendence	Push on	Act
	Wrap it up	Act

Generally, the conation level depends on classroom surroundings and learning engagement (innovative instruction and support services by the instructor), or collaborative environment [7],[25]. An environment can also have a major influence that will affect students in deciding to achieve goals [26]. According to Atman (1987), the success of learners depends on two factors (i) conative domain in terms of striving skills and (ii) carefully constructed teaching and learning environment [15]. Not every student has this capability to strive on their own. Hence, it is crucial for educators to provide support to activate students' conation through a supportive learning environment [15].

The first year is the most crucial part of university life, where academic failure and unsuccessful transition always happen [10]. Many universities put efforts into supporting first-year engineering students, amongst them through the implementation of introductory engineering courses [12]. The Introduction to Engineering course (ITE) course described earlier was studied as it promotes a supportive learning environment for the first-year engineering students to learn engineering [13].

Methodology

This study utilized the Goal Orientation Index (GOI) to measure students' conative behavior at pre-and post-test using SPSS and Rasch analysis. The survey was carried out from September 2018 to December 2018 amongst first-year engineering students taking Introduction to Engineering (ITE) courses in one of the universities in Malaysia. In this course, students learn together in a cooperative learning team to resolve various active learning activities such as; peer teaching, brainstorming, presenting, interviewing engineers, reflecting, discussing, planning, finding information, data collecting, analysing, solving an engineering problem, presenting ideas, and report writing and oral presentation. Table 3 shows the implementation of the teaching and learning environment in the ITE course [14].

Table 3: Implementation of an introduction to engineering in the ITE course

	ITE course (3 credit hour)
Aims	- Prepare students for learning engineering to become an engineer - Bridge pre-university education to university life and provide support to students - Equip students with important professional skills
Assessment	Report on Engineering Overview Mini Project, Ethic case study, Quiz (1,2), CPBL Report (Stages 1,2,3), Presentation (Stages 1,2,3), Video, e-learning, PR & PI (problem restatement & problem identification), Peer teaching notes (Stage 1,2,3), Test, Reflection, Peer Rating
T&L approach	Cooperative learning Cooperative Problem-based learning
Methods	Conducted through in-class activities where students in a group of 4 are given 3 stages of sustainability problems that require innovation engineering solutions
Transferable skills	Team working, communication, problem solving & life-long learning
Teaching and Learning activities	Peer teaching, brainstorming, progress check, peer rating, peer teaching notes, oral presentation and report, interview engineer, in-class facilitation for individual team's feedback, individual reflection, Plus-Delta for team's improvement, team logbook and overall class discussion.

A supportive learning environment is attained in the course by implementing Cooperative Problem-based Learning (CPBL) [14]. CPBL is the integration Cooperative

Learning (CL) principles into the Problem-Based Learning (PBL) process. CPBL has been shown to improve students' learning while developing desired professional abilities, increase motivation for learning strategies and deep learning, and develop team-based problem-solving skills [14]. The CPBL cycle provides a scaffolding for students to solve complex and open-ended engineering problems systematically. As shown in Figure 2, the CPBL process consists of three phases: Phase 1 is problem restatement and identification, Phase 2 is peer teaching, synthesis of information, and solution formulation, and Phase 3 is a generalization, closure, and reflection [27].

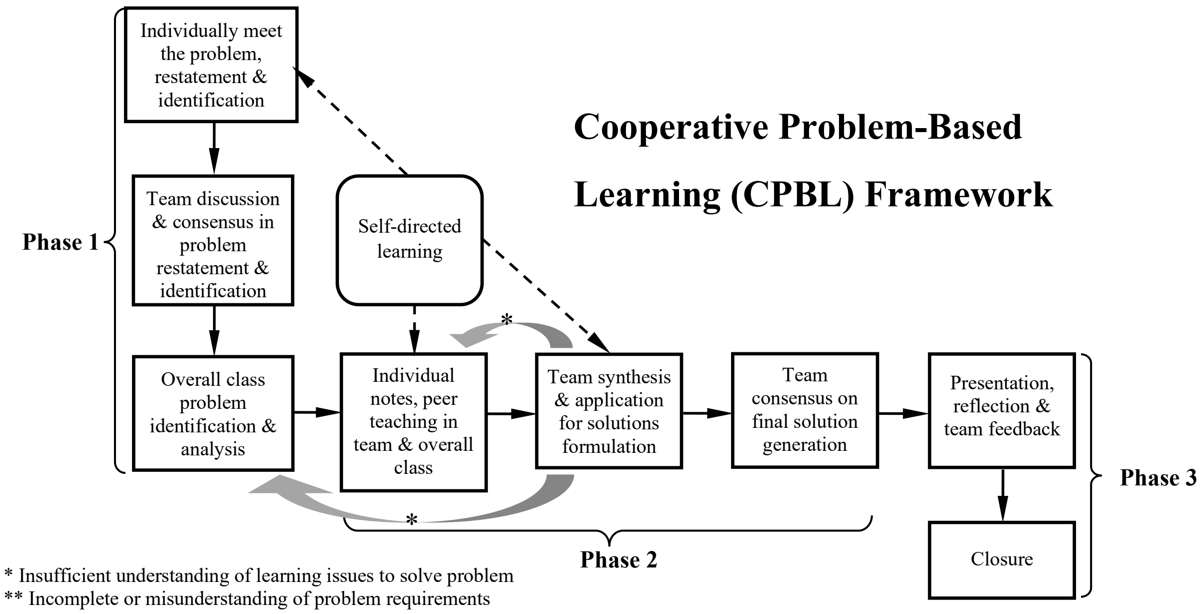

Figure 2: CPBL framework

In a team of three to four students, students were given a semester-long sustainable development-based problem. Examples of the themes for the problems given include renewable energy, river conservation, low carbon society, consumerism, solid waste management, etc. Problems are crafted and posed such that students become immersed to learn, investigate and propose a possible engineering solution. The semester-long problem is divided into three stages, in which students go through a complete CPBL process in each of the three stages. Stage 1 requires students to learn about SD so that they can find information on the current world scenario related to the given problem, and benchmark current efforts in Malaysia with other countries. Stage 2 is focused on requiring students to observe, measure, and collect data on the specific activity related to the SD theme in their lives as a student and with their families to analyse the pattern of behavior that can help them identify a specific problem that should be solved. Stage 3 required them to propose a sustainable and practical engineering solution to the problem, which was then presented to the professionals who work in related areas in an exhibition at the end of the semester [14].

Goal Orientation Index (GOI) Instrument

The GOI, which has 96 items, consists of three main constructs (plan, act and reflect) and twelve sub-constructs that describe the striving behaviour, as shown in Table 4. The GOI identifies twelve sub-constructs which are Recognize Problem (RP), Purpose Long-Range Direction (PU), Set Goal (SG), Organise (OR), Select Strategy (SS), Make it Happen (MH), Push On (PO), Wrap it Up (WU), Brainstorming (BR), Assess Risk (AR), Get your Act in Gear-Visualize (ACT) and Ooo & Ahh! - Evaluate (OA). The codes and item numbers describe the details of each sub-construct. For example, code SSG8 and ESG8 represent the pre-test and post-test respectively, for item no 8 under sub-construct Set Goal (SG).

Table 4: Sub-constructs and items number under construct plan, act and reflect.

Construct	Sub-constructs	Code		Item No.	No of items
		Pre-test	Post-test		
Plan	SG	SSG	ESS	3, 8, 25, 47, 53, 63, 77, 92	8
	RP	SRP	ERP	10, 32, 40, 57, 62, 71, 74, 86	8
	PU	SPU	EPU	2, 14, 17, 31, 38, 67, 81, 93	8
	OR	SOR	EOR	16, 19, 34, 37, 39, 46, 73, 82	8
Act	MH	SMH	EMH	5, 9, 52, 58, 68, 70, 83, 87	8
	WU	SWU	EWU	1, 20, 21, 26, 51, 56, 80, 89	8
	PO*	SPO	EPO	12, 18, 24, 60, 66, 72, 78, 96	8
	SS*	SSS	ESS	6, 30, 36, 42, 48, 54, 84, 90	8
Reflect	ACT	SACT	EACT	7, 41, 59, 61, 65, 69, 88, 95	8
	BR	SBR	EBR	4, 11, 15, 22, 27, 43, 79, 85	8
	OA	SOA	EOA	23, 28, 35, 49, 50, 55, 91, 94	8
	AR	SAR	EAR	13, 29, 33, 44, 45, 64, 75, 76	8

The GOI addresses how conative instincts affect individual performance when striving toward a goal [15]. It consists of five-Likert scales that require the respondent to choose how they *rarely*-do to *almost always*-do in response to single-sentence problem-solving or behavioral scenarios. The GOI was distributed to students at the beginning of the semester and at the end of the semester. The pre-course data was used to check the instrument validity and reliability. The post-test data was compared with pre-test data to study whether students have increased agreement on the items after they had undergone the course.

The respondent of this study is 30 first-year engineering students enrolled in the ITE course in that semester. According to Wright and Tennant (1996) as cited in Talib et al. (2019) [28], a minimum of 30 students is sufficient to evaluate the item's quality. Meanwhile, in Michael Linacre's guideline, the items calibration or person measures are stable within ± 1 logit, at the confidence level of 99%, the minimum size for most purposes for polytomies using Likert-scales items can be from 27 students [29]. In addition, Creswell as cited in Onwuegbuzie and Leech (2005) considered 30 respondents to be the minimum acceptable sample for quantitative research [30]. In this study, several data analysis method was utilized to investigate the activation among 30 first-year engineering students' conation, which is:

i. Rasch instrument analysis (reliability and separation index, fit statistics, and unidimensionality) to evaluate items functionality of the GOI instrument
ii. Descriptive statistics using SPSS (mean and standard deviation) to investigate the activation of students' conation
iii. Inferential statistics using SPSS (paired sample t-test) to determine the significant difference in students' conation
iv. Person-item distribution map (PIDM) using the Rasch model to investigate students' perception of agreement or disagreement towards each item

Instrument analysis using Rasch Model

The 96-items GOI was first introduced by Kathryn S. Atman, who previously studied the goal accomplishment style and psychological types amongst middle school students in the United States [8]. In this study, the GOI instrument was distributed to different populations and environments, which is the first-year engineering students in one of the universities in Malaysia, which may affect the items' reliability and validity.

The Rasch measurement model is used to assess the psychometric properties in terms of reliability and validity of the instrument, facilitate the instrument development, and provide data that can be used for descriptive and parametric statistics, before the data collection begins [31], [32]. The Rasch model is also based on a probabilistic model which involves two important parameters to be tested which are item difficulty and person ability that is presented in an equal interval in the Rasch calibrated scale [31],[32]. In addition, the Rasch model was used to examine various aspects of item functionality of an instrument such as (i) items and person reliability, (ii) items and person separation index, (iii) unidimensionality, and (iv) fit statistic [32].

In the reliability test for the GOI data for the Malaysian respondents, the analysis produces two different tests which are Rasch person reliability and the item reliability indices. The reliability value can be measured based on the internal consistency value of Cronbach alpha (α), which can range from 0-1, where the minimum value of Cronbach alpha, α, is considered reliable at α=0.60 [33],[34],[35],[36]. Table 5 shows that the Rasch person reliability and the item reliability indices for all sub-construct were reliable as the value of Cronbach alpha, α, for items (α_{item}) and person (α_{person}) has exceeded 0.70 (α_{item}>0.7 and α_{person}>0.7). This shows that all items are reliable to be tested and no modification should be made for the Malaysian respondents.

Table 5: Reliability and Separation of each sub-construct.

Construct	Sub-Construct	Person		Item	
		Reliability (α)	Separation (s)	Reliability (α)	Separation (s)
Plan	SS	0.87	2.57	0.93	3.58
	MH	0.73	1.65	0.82	2.14
	PO	0.80	2.02	0.86	2.49
	WU	0.76	1.78	0.94	3.89
Act	RP	0.73	1.64	0.88	2.67
	SG	0.82	2.14	0.94	3.84
	OR	0.83	2.23	0.81	2.08
	PU	0.90	2.92	0.85	2.38
Reflect	BR	0.80	2.01	0.89	2.89
	AR	0.77	1.83	0.72	1.64
	ACT	0.78	1.91	0.71	1.56
	OA	0.82	2.13	0.70	1.54

Another important analysis is to investigate the separation index for persons and items. The person separation indices indicate how well a set of items separates person measures as its sensitives enough to distinguish between high and low performers. Meanwhile, the items separation indices indicate how well a sample person is able to separate the items, which the person is able to confirm the items' difficulty hierarchy of the instrument. The separation index value can range from 0 to infinity; the higher value indicates a better separation. The separation index of 3 and greater is considered excellent and a minimum separation index of S=1.5 is considered acceptable [35],[32]. From Table 5, the index value of the person separation S_{person} (S_{person}>1.64), and the item separation, S_{item} (S_{item}>1.54), is greater than 1.5 for all sub-constructs. As the separation index has met the minimum requirement, this indicate that the respondents are able to separate items in each sub-construct (S_{item}>1.5) and show that these items are able to separate persons measured (S_{person}>1.5) [37].

The unidimensionality test was conducted to ensure that the items in the instrument only measure a single construct [36]. The unidimensionality test measures several components which is: (i) variance explained by measure, (ii) unexplained variance in 1st contrast, and (iii) eigenvalue. From the results, the variance explained by measure (a), unexplained variance in first contrast (b) and eigenvalue(e) has meet the minimum requirement of a>20% [36], b<15% [38], e<3.0 respectively [29].

Meanwhile, in fit statistics, three criteria were commonly reported: mean squared (MNSQ), z standardized (ZSTD), and point measure correlation (PMC). According to the rules, either one out of three criteria is to be achieved and bound in range. The rules are PMC (x where 0.4<x<1.0), MNSQ infit/ outfit (y where 0.5<y<1.5) and ZSTD infit/outfit (z where -2<z<+2) [33],[34]. In fit statistical analysis, several items under sub-construct SS, MH, WU, PO, OR, PU, AR, RP, ACT, OA at pre-and post-test have fallen outside the range and are categorized as suspected misfit items. From the data analysed, all these items are bound within the PMC range (0.4<x<1.0). According to the rules, these items are accepted as a fit item. Hence none of the items in the questionnaire shall be deleted as misfit items and acceptable for further analysis.

Descriptive and Inferential Statistics using SPSS

The data collected from the GOI instrument was analysed using SPSS analysis to investigate the summary of the samples and observations that have been made. The SPSS analysis was presented in two subdivisions which are descriptive statistics and inferential statistics. Descriptive statistics describe a summary of the data and presentation of the numerical facts that are presented in a table or graphical form, with the method to analyse the data [39]. In this study, descriptive statistics were used to elaborate the mean and the standard deviation from the GOI data.

Meanwhile, inferential statistics involves techniques for making inferences from the sample that can represent the whole population. In this study, the inferential statistics were conducted using paired sample t-test to compare the mean of a single group and examine two different points in time [40]. The paired sample t-test was used to test whether there is a significant difference in students' conation based on pre-and post-test marks obtained from the GOI instrument. The paired-sample t-test was employed to test the hypothesis of this study:

H_o: There are no statistically significant differences in first-year students' conation after learning in a supportive learning environment in introductory engineering class.

Person item Distribution Map (PIDM) or Wright Map

Another analysis using Rasch is the person-item distribution map (PIDM) or Wright Map. The PIDM is a graphical illustration map that transforms the distribution of items and person data from the GOI instrument into an equal interval called the 'logit' scale [36]. The PIDM describes various levels of difficulty agreement towards items and persons' agreement towards each item in Rasch calibrated scale [32]. PIDM indicates the difficulty of the items (item-measure) can be computed using the same linear scale that is used to express a persons' performance (person-measure) [32]. Presented in a graphical presentation, the PIDM illustrates respondents' abilities, and spread of the items at pre and post-test to investigate their agreement or disagreement towards each item in the GOI instrument.

Figure 3 shows the example of a person-item distribution map (PIDM) in Brainstorming (BR) sub-construct at pre-and post-test data. The code SBR (start of the semester for BR sub-construct) and EBR (end of the semester for BR sub-construct) represent the pre-test and post-test under sub-construct BR, and the number from 1 to 8 is referred to the number of the items. The PIDM reveals students' ability to respond to items in each sub-construct. The right side of PIDM shows the 'Item' spread under the BR sub-construct. The left side shows the 'Person' spread, which refers to the thirty students who answered the instrument. In PIDM, the 'items' spread is plotted on the right side of the same vertical line in descending order and is referred to as the most difficult item "to agree with" to the easiest item "to agree with" [38].

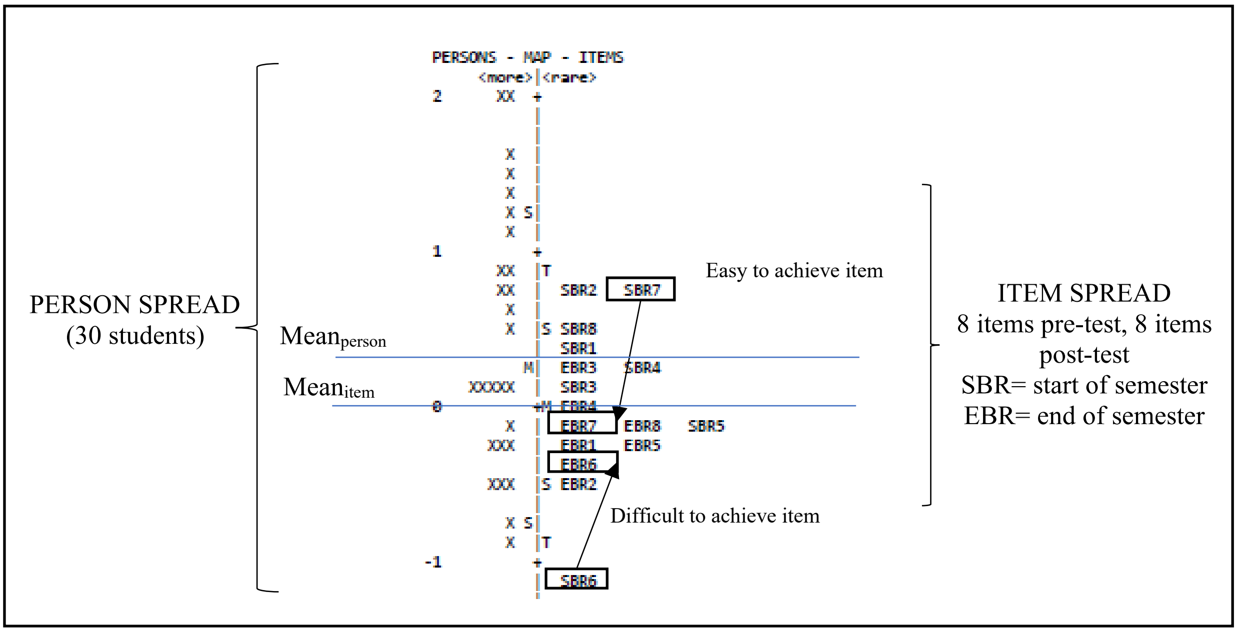

Figure 3: Example of PIDM under BR sub-construct

Results and Discussion

This section discusses the results and analysis from descriptive statistics and inferential statistics using SPSS and the person-item distribution map (PIDM) or Wright map using Rasch analysis. The descriptive statistics was employed to investigate the potential activation of students' conation, taking from the mean-value at pre-and post-test. Meanwhile, the inferential statistics were utilized to determine if there is any significant difference in students' conation between the end and the beginning of the semester using paired sample t-test. Finally, the PIDM or Wright Map using Rasch was performed to analyse item-by-item in each construct to inspect students' agreement or disagreement in the pre-and post-tests. The results from statistical analysis and item-by-item analysis in PIDM are then aligned to learn the potential conation activation among students.

Descriptive statistics

Analysed using SPSS, the descriptive statistical analysis covered the $Mean_{post}$, $Mean_{pre}$, ΔMean, and SD values as in Table 6. Referring to the table, students perceived that they have activated the constructs of "Plan" and "Reflect" since the mean values of the subconstructs at post-test are all higher than pre-test ($Mean_{post} > Mean_{pre}$). However, for the "Act" construct, the mean for the subconstructs SS* and PO* decreased because the sub-construct only consists of items with negative statements. Thus, the results of the post-test should be lower than the pre-test ($Mean_{post} < Mean_{pre}$), as it indicates that the students did not agree with the negative statements. This shows that the "Act" construct was also activated. Meanwhile, in standard deviation, the value at post-test is lesser than pre-test. This defines that the data points tend to be close to the mean of the data. Therefore, the overall results show that students perceive that they have gained activation in the three constructs of the conative domain after undergoing the ITE course.

Table 6: Descriptive statistical value for 12 sub-constructs of conative behavior

Construct	Sub-Construct	Mean		SD		ΔMean
		Pre	Post	Pre	Post	
Plan	RP	3.325	3.4625	0.52789	0.45266	0.1375
	SG	3.4667	3.6458	0.7719	0.73335	0.1791
	OR	3.2958	3.3167	0.93339	0.83675	0.0209
	PU	3.1333	3.3833	1.03074	0.80805	0.25
Act	SS*	2.7583	2.5917	0.75354	0.73618	-0.1666
	MH	3.5875	3.6917	0.55042	0.62088	0.1042
	PO*	2.8208	2.7458	0.81055	0.81041	-0.075
	WU	3.5042	3.5958	0.66992	0.63031	0.0916
Reflect	BR	3.1625	3.4042	0.6832	0.66524	0.2417
	AR	3.2833	3.5042	0.53026	0.67553	0.2209
	ACT	3.5875	3.7125	0.79881	0.75939	0.125
	OA	3.5417	3.7625	0.78875	0.64773	0.2208
	N=30R					

Inferential statistics using Paired sample t-test

Table 7 below shows the paired-sample t-test analysis for twelve sub-constructs at pre- and post-test to investigate the study's hypothesis (H_o: There are no statistically significant differences of first-year students' conation after learning in a supportive learning environment in introductory engineering class). According to the results, the p-value of all twelve sub-constructs fell just short of statistical significance as the p-value surpassed 0.05 ($p>0.05$). In sub-constructs Purpose long-range direction, PU (p=0.09), Brainstorming, BR (p= 0.07) and Assess risk, AR (p=0.08), the p-value are close to the limit of the significance level p=0.05, which indicates that these sub-constructs close to having significant levels in conation. Meanwhile in sub-construct Recognize problem, RP (p= 0.16), Set goal, SG (p=0.22), Select strategy, SG (p= 0.27), Make it happen, MH (p=0.30), Wrap it up, WU (p=0.31), Get your act in gear, ACT (visualize) (p=0.27) and Ooo & Ahh, OA (evaluate) (p=0.19), the p-value was moderate trend toward statistically significance level. However, for sub-construct Organize, OR (p=0.86) and Push on, PO (p=0.56), the p-value did not reach a statistically significant level as it has a high number of a p-value. Based on the results, the null hypothesis shall be accepted, that the differences in first-year students' conation at the beginning and end of the semester are not statistically significant.

Table 7: Paired sample t-test analysis

		Paired Differences	t	df	Sig. (2-tailed)
		95% Confidence Interval of the Difference			
		Upper			
Pair 1	Mean_SRP - Mean_ERP	0.057	-1.441	29	0.16
Pair 2	Mean_SSG - Mean_ESG	0.110	-1.264	29	0.22
Pair 3	Mean_SOR - Mean_EOR	0.215	-.180	29	0.85
Pair 4	Mean_SPU - Mean_EPU	0.047	-1.719	29	0.09
Pair 5	Mean_SSS - Mean_ESS	0.470	1.123	29	0.27
Pair 6	Mean_SMH - Mean_EMH	0.099	-1.046	29	0.30
Pair 7	Mean_SPO - Mean_EPO	0.332	.595	29	0.55
Pair 8	Mean_SWU - Mean_EWU	0.088	-1.043	29	0.31
Pair 9	Mean_SBR - Mean_EBR	0.020	-1.886	29	0.06
Pair 10	Mean_SAR - Mean_EAR	0.032	-1.782	29	0.08
Pair 11	Mean_SACT - Mean_EACT	0.102	-1.125	29	0.27
Pair 12	Mean_SOA - Mean_EOA	0.117	-1.336	29	0.19

According to McCoach (2013), evaluation of psychological aspects, especially affective or conative, is not directly observable, making the measurement complicated [41]. This is also supported by the previous studies from Atman and colleagues, as there is no pre- and post-data analysis using the GOI instrument to investigate the significant difference in students' conation, as differences in conation is not easily developed in a short period of time [8], [15]. In addition, Onwuegbuzie and Leech (2005) stated that a sample size of 30 was too small to detect a significant difference in the construct [30]. Besides that, the Likert-scales instrument using GOI that specifies people with higher scores should tend to agree with favorable items and vice versa, does not help discriminate between high and low scorers on the scale [41]. Another factor why students' conation is not significant is because the non-cognitive dimension of attitudes (i.e: affective and conative) toward an object might be uncommon. Hence, specific scales' dimensions might not be comparable [42].

Person- Item Distribution Map (PIDM)

According to the paired sample t-test, the results indicated that the value of p>0.05. This indicates that there is no significant difference in students' conation at pre-and post-test. Hence, further analysis of students' perceptions of each item was investigated using a person-item distribution map (PIDM analysis). The PIDM was conducted to support the descriptive statistic results (especially mean scores) for in-depth understanding. The PIDM analysed items' difficulties and person abilities in answering the survey items. The PIDM produces the abilities of respondents and spread of items at pre and post-test to investigate the students' agreement and disagreement on items in planning, acting, and reflecting construct.

a. Planning Construct

The Planning construct consists of set goals (SG), recognize the problem (RP), purpose long-range direction (PU) and organize (OR). The PIDM in Figure 3 indicates that students have reached their agreement in answering the items as the $Mean_{person}$ is located higher than the $Mean_{item}$ above 0.00 logit. According to Figure 4, the 'easiest to achieve' items agreed by the students under sub-construct PU was EPU1 (post-test: I have set some long-range goals for myself), EPU6 (post-test: I have a plan for my career development), while the most 'difficult to achieve' item was SPU7 (pre-test: I have a life plan that makes use of my specific talents). Meanwhile, in sub-construct OR, the most 'easiest to achieve' items agreed by the students was EOR5 (pre-test: I organize the materials I will need for a job before I begin it), while the most 'difficult to achieve' item was SOR6 (pre-test: I am well organized). In sub-construct RP, the most 'easiest to achieve' items agreed by the students was ERP2 (post-test: I can tell the moment that things start to go wrong), and the most 'difficult to achieve' item was SRP1 (pre-test: I can recognize problems at the time they occurred). Lastly in sub-construct SG, the most 'easiest to achieve' item agreed by the students was ESG6 (post-test: I set goals for myself), while the most 'difficult to achieve' item was SSG2 (pre-test: I take advantage of opportunities when I see them). From the analysis, we can see the pattern of items' spread where students start with the disagreement in pre-test items, but at the end, they reached an agreement on post-test items.

Figure 4 shows the item-by-item analysis using PIDM according to students' agreement for planning construct. From the PIDM, various items at post-test spread to the bottom of map compared to pre-test. For example, items under the sub-construct PU, PU3 (I have set guidelines for my future development), and PU1 (I have set some long-range goals for myself) were defined as 'difficult to achieve' items at pre-test, become 'easy to achieve' items at post-test, since the items were spread to the bottom of the map. However, items PU4 (I know what I want to do with my life) and PU5 (I have a plan for my personal development) become the less agreed-upon items by the students. In sub-construct OR, students have the most agreement in items OR1 (I write down the list of things I need to do), OR5 (I organize the materials I will need for a job before I begin it), and OR8 (I plan systematically to get things done) since it become the most 'easiest to achieve' items at the end of the semester. In contrast, item OR3 (I plan my work in order to use time well) went the opposite way. Meanwhile, for sub-construct RP, items RP2 (I can tell the moment that things start to go wrong), RP6 (I can recognize needs that must be satisfied), and RP7 (I can see when I face a challenge) which was defined as 'difficult to achieve' items at pre-test, becomes 'easy to achieve' items at post-test. However, items RP5 (I can see opportunities where other people can't) and RP8 (I am aware when changes start to take place) become the less agreed items by the students. Lastly in sub-construct SG, students have the most agreement in items SG2 (I take advantage of opportunities when I see them), SG5 (when I see something that needs to be done, I decide what I am going to do about it), and SG8 (when I set a goal, I know how things will be when I have met the goal) since it becomes the most 'easiest to achieve' items at the end of the semester. In contrast, item SG7 (I have a clear idea of what I want to do before I start) went to the opposite way after learning in the ITE course.

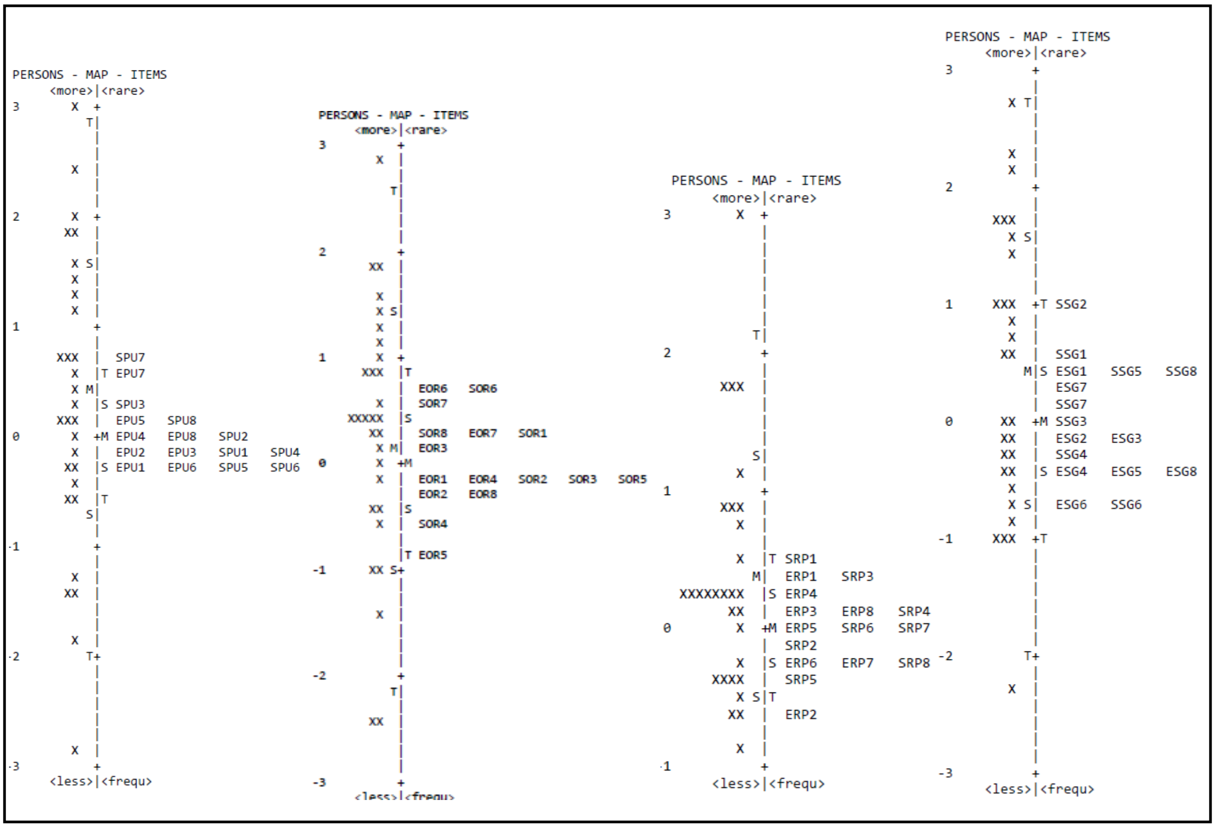

Figure 4: Person-Item Distribution Map in Planning construct

In the Planning construct, the results demonstrate that students have higher agreement in SG, RP, PU, and OR at the end of the semester compared to the beginning ($Mean_{post} > Mean_{pre}$). From the means score of RP at the end of the semester, students agree that they recognized the problem in learning and understood the need to overcome a challenge. Learning in the ITE course requires students to work on real-world problems and get exposed to the discipline of engineering and the scope of work of an engineer [14]. In phase 1 of the CPBL process, students need to get familiar with the engineering problem, as they need to identify and restate the problem before moving to the next phase. They made individual peer teaching notes based on their information findings and be clear with the problem before discussing it in their team to produce a team peer teaching note. Thus, it is not surprising to see that the mean score of PU at the end of the semester indicates that students agree that they understand the importance of long-range planning for career development in this course and have set guidelines for their future development. In ITE class, students work in a team, find information, benchmarking, analyse and synthesize the data, produce an engineering report, and present their solution to help them get exposure to what is engineering, the potential job scope, and profession. Students agree that they set a goal to identify a need, challenge, and opportunity to complete the project through this course (SG), but also perceive that they were fuzzy at the beginning and must have a clear idea of what to do before they start the project. Students agree that they organize their learning material, manage their time properly, and plan systematically for their future work (OR). In CPBL, a three-stage sustainable development-based problem trains and guides students to manage their time well and plan their learning across the semester. Learning in ITE class involves active learning activities and must be completed alongside their teammates. Students were guided to organize and manage their workload to plan with Gantt charts during the class as it will affect their task and team project.

This course is purposely designed to stimulate students' innate force to have the purpose of setting their goals and plan accordingly as part of learning engineering process [1]. Kuchi et al. [43] who noted that students who learn in a real-world problem can nurture their competence and strive toward gaining knowledge [1],[43]. Various activities involved such as defining the problem, identifying learning issues, and coming up with action plans, also helps students to manage their goals, keep track of their progress in planning and use time effectively [22].

b. Acting Construct

The Acting construct consists of make it happen (MH), wrap it up (WU), select strategy (SS), and push on (PO). From Figure 5, the PIDM describes items in sub-construct MH & WU spread at the middle and below the $Mean_{item}$, meanwhile, the negative items (SS* & PO*) spread on the top of the map. This occurred since students have the least agreement on the negative items (SS* and PO*) as they perceive the items were 'difficult to achieve'. This was proven as the $Mean_{person}$ of SS* and PO* are lower than the $Mean_{item}$ below 0.00 logit. The PIDM also describes that the items under MH and WU have reached the level of students' agreement, as the $Mean_{person}$ is higher than the $Mean_{item}$ above 0.00 logit. This explained that the students have reached their agreement in answering the items in MH and WU. This was aligned with the descriptive statistical results as the mean value of PO* and SS* has decreased ($Mean_{post}$ <$Mean_{pre}$) at post-test, while the mean value in MH and WU has increased ($Mean_{post}$>$Mean_{pre}$) at post-test. This explained that students have gained a potential activation in this construct.

As shown in Figure 5, the items agreed by students in sub-construct MH were MH3 (As I work on a project, I pay attention to how things are going) and MH8 (I notice when something doesn't work out the way I expect it to). These items are defined as 'difficult to achieve' items at pre-test but become 'easy to achieve' items at post-test. In contrast, items MH7 (I pay attention to new information and change my plan if need to) become the less agreed items by the students. For sub-construct WU, students reached the most agreement in items WU3 (I can maintain the effort needed to finish a project) and WU6 (I complete what I start) since they are the most 'easiest to achieve' items at the end of the semester. In contrast, item WU8 (I achieve the goals which I have set for myself) went the opposite way. The negative items in sub-construct SS*, students perceived that they have agreed in item SS5 (It is hard for me to choose which way to do something) but have less agreement in items SS1 (When I have to make a choice, it is difficult for me to decide what to do) and SS2 (It isn't easy for me to decide what course of action I should take). Lastly in sub-construct PO*, students have reached the most agreement in items PO7 (I get panicky when a deadline approaches) since it becomes the most 'easiest to achieve' item at the end of the semester. In contrast, items PO1 (I start projects on a strong note but lose momentum as I go along) and PO4 (I don't start things even though I know that they need to be done) went the opposite way at the end of the semester.

In the Acting construct, the results demonstrate that students have higher agreement in MH and WU at the end of the semester compared to the beginning ($Mean_{post}$>$Mean_{pre}$). The supportive environment in the ITE course using an active learning environment encourages students to take action in completing the project. The mean score of MH at the end of the semester indicates that students agreed to the statement that they have put effort into their work, be aware of any situation, pay attention while working on a project, and keep track of the new information. Tinto [44] stated that students persist and retain better in an environment that allows them to be socially and academically involved during the learning process. In this course, students were supported to learn in a cooperative environment, and it inspires students to be accountable to complete the task in a team. Students also perceive that they can finish the project on time from the mean score of WU at the end of the semester, but still need to improve in meeting the time deadlines. This course also encourages students to keep their momentum to complete the project as it involves a continuous project from the beginning until the end of the semester. Students perceive that they were strongly task-oriented and took pleasure to finish the job until the end of the project (PO), but also agreed that they panicked when a deadline approached. This happens as the ITE course contains many activities and tasks that must be completed within a certain amount of time. In decision making, students perceived that they felt overwhelmed to decide which action to take, although they were able to decide, take possible action to complete the project, and become more conclusive in selecting the strategy (SS). The in-class activities such as progress check, team discussion, peer-teaching, planning for the Gantt chart, reflection writing, and more encouraged is designed to guide students to have aims in goal setting, which is essential to support students to become a productive learner [17] that will offer potential for effective learning [19] and lead to better academic performance [23]. Students who learn in an active learning process and receive support from learning communities through culturally appropriate instruction can develop social learning and instil students' self-directed learning [43].

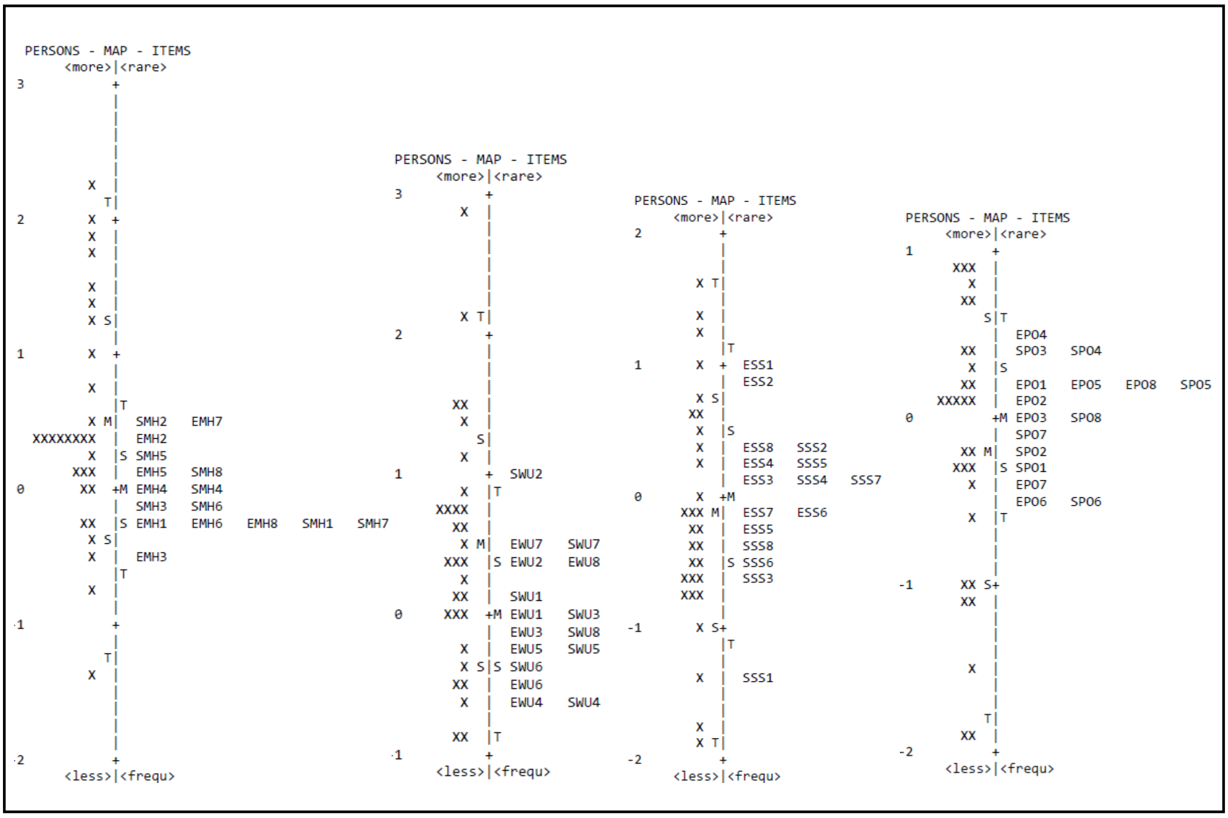

Figure 5: Person-Item Distribution Map in Acting construct

c. *Reflecting Construct*

The Reflecting construct consists of brainstorming (BR), assess risk (AR), get your act in gear (ACT), and ooo & ahh (OA). The PIDM in Figure 6 indicates that students have reached their agreement in answering the items, as the $Mean_{person}$ is located higher than the $Mean_{item}$

above 0.00 logit. This is aligned with the descriptive statistics results as the mean value at post-test was higher than the pre-test ($Mean_{post}$>$Mean_{pre}$) which describes that students have gained activation under the reflective construct. This is also supported in PIDM as various items at a post-test spread to the bottom of the map compared to the pre-test. Figure 6 shows the item-by-item analysis using PIDM according to students' agreement with the Reflecting construct. For example, in the BR sub-construct, the most items agreed by students were items BR1 (I think of various ways I can do something before I start) and BR2 (When I see an opportunity, I think of several ways to take advantage of it) was defined as 'difficult to achieve' items at pre-test, becomes 'easy to achieve' items at post-test, since the items were spread to the bottom of the map. However, items BR6 (Before I start to do something, I consider different ways to go about it) become the students' less agreed items. In sub-construct AR, students have the most agreement in items AR2 (I examine risks before I do something) and AR4 (I like to "figure the odds of success for what I do) since they become the most 'easiest to achieve' items at the end of the semester. In contrast, item AR6 (Before I start a project, I figure out the chances I may have to take to accomplish it) went to the opposite way. For sub-construct ACT, items ACT3 (I mentally go over the method I am going to use to get something done before I start) and ACT7 (I encourage myself) were defined as 'difficult to achieve' items at pre-test, become 'easy to achieve' items at post-test. However, items ACT2 (I imagine how I am going to do something before I actually do it) become the less agreed items by the students. Lastly in sub-construct OA, students perceived they have the most agreement in items OA1 (After I finish something, I check to be sure that everything was done correctly), and OA4 (When I finish something, I stop and think back about how things worked out before I go on to something else) since it becomes the most 'easiest to achieve' items at the end of the semester. In contrast, item OA8 (When a project is finished, I see how close it comes to my original goal) went to the opposite way after learning in the ITE course.

In the Reflecting construct, students have higher agreement in ACT, OA, AR, and BR at the end of the semester compared to the beginning ($Mean_{post}$>$Mean_{pre}$). The reflective session and formative assessments in the ITE course using peer and instructor feedback, reflection, peer rating, and comments on reports and presentations encourages students to reflect on their past experiences. This is in-line with findings that supportive environment allows students mentally rehearse the planning activity and evaluate/critique all aspects of work to improve future tasks [24]. From the mean score of ACT at the end of the semester, students agree that they can visualize things before the project starts (ACT). In phase 3 of CPBL, after the project submission, students were guided to review and evaluate past experiences to ensure everything was done properly and avoid making mistakes for future improvement (OA). The discussion and brainstorming session in class encouraged students to examine possible risks, suspend judgment or initiate alternative ways (AR) and brainstorm various opportunities before decisions were made (BR). As stated in Atman's findings, students who are trained in a supportive learning environment with goal-oriented striving behavior enabled them to become more aware/conscious of the consequences of his/her action [22].

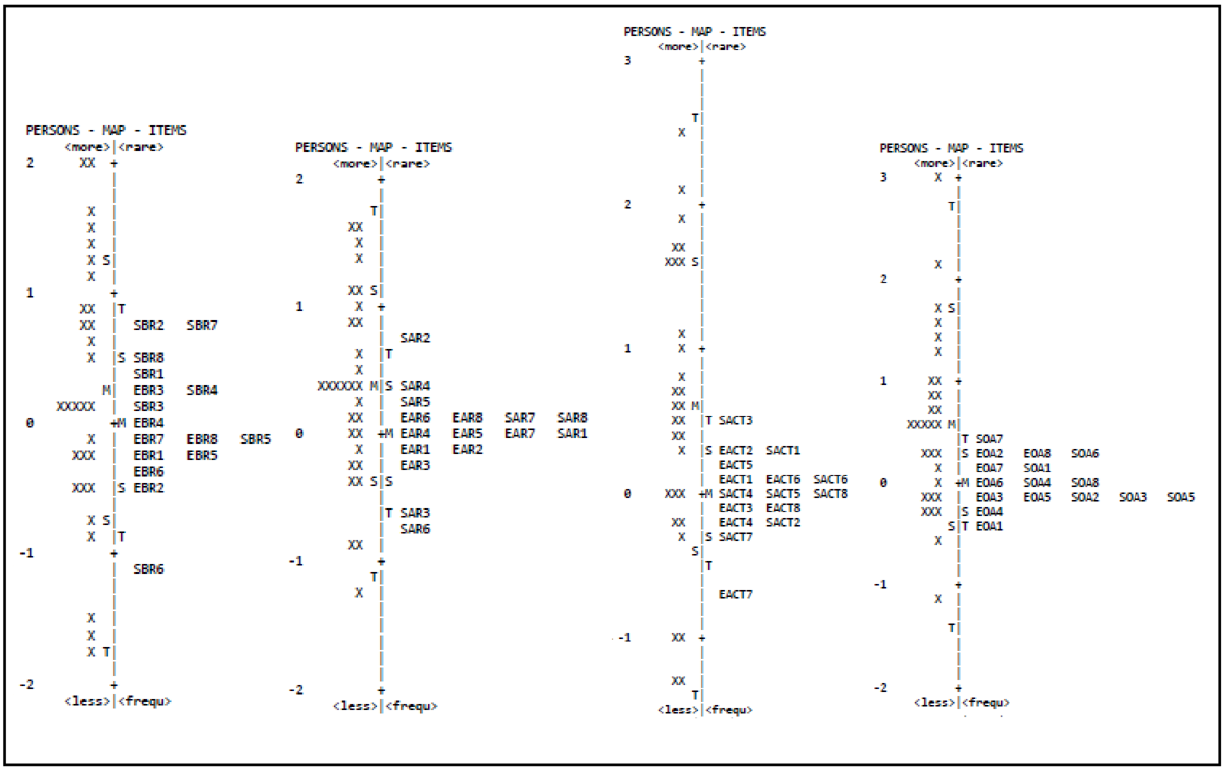

Figure 6: Person-Item Distribution Map in Reflecting construct

Overall Discussion and Conclusion

This study investigates whether first-year engineering students' conation can be activated after learning in the ITE course. In terms of fundamental instrument analysis using Rasch, the GOI instrument was considered valid and reliable for data collection for engineering students in Malaysia. From the results, this study implies that learning in a supportive environment using CPBL provides the potential to activate students' conation. The descriptive statistics results showed an increment in mean values for all sub-constructs and the PIDM showed students' agreement in most of the items under planning, acting, and reflecting constructs. This indicates that providing support at the tertiary level, specifically in a supportive learning environment, has the potential to activate students. However, the inferential statistics using a paired-sample t-test showed that there is no significant statistical difference in students' conation at pre-and post-test as the p-value exceeds 0.05 in all constructs. This may occur since conation are not easily enhanced within a short period of time, which led to the limitation of the study. The small sample of the respondents also affects the statistical data as it provides a low standard deviation, small difference in mean values (ΔMean), and affecting the significant difference in the construct as p-value >0.05. From the PIDM analysis, although the result describes a potential activation in students' conation, it is not possible to generalize in detail the improvement in students' conation. To further understand the activation of conation in each construct, further study will be done using qualitative data based on observations and interviews. Nevertheless, this study shows that implementing a supportive learning environment in the classroom has the potential to activate students' conation, although the results show the mean difference to be not significant.

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