RESEARCH BRIEF

Thai Vocational Internship Student-Teacher Development Through a Constructionism Learning Skills Model

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Evolving business needs, technological advances, and new work structures are redefining what are considered to be valuable skills for the future, but determining what these are is far from straightforward. In particular, the advancement of communication and technology has changed working styles, and according to Paul Cappon, former president of the Canadian Council on Learning, predicting what skills people need 20 years from now is impossible (Cooper, 2017). Skills are also highly context-dependent and multifaceted.

Dr. Helen Soulé, executive director of the Partnership for 21st Century Skills (P21, n.d.) which developed its own framework to support schools in skills development, felt that a cross-curricular approach is key. Contained within the P21 framework is "the four C'", which are identified as communication, collaboration, critical thinking, and creativity. When students possess these skills alongside content knowledge, they are more likely to be successful in college, in the workplace, and as citizens. Reeve (2016) has also stated that 21st century skills are abilities that students need as they compete in the information age. The Economist Intelligence Unit Limited's (2015) report also identified and added these skills: leadership, digital literacy, problem-solving, and communication.

However, according to the results from multitudes of international studies, the current model of learning management in Thailand does not appear to be the correct answer for 21st century student's social and educational needs. In 2016, 5.79% of Thailand's GDP was spent on education, compared to Singapore's 3.23%, or 79% more than Singapore (NationMaster, 2017), but testing results for this expenditure are abysmal.

In 2015, Thailand allocated 19.3% of its national budget, or US$15.22 billion (Saiyasonmbut, 2014), yet the latest World Economic Forum report on education ranked Thailand last out of eight Association of Southeast Asian Nations (ASEAN; ICEF Monitor, 2015). In the 2015 Programme for International Student Assessment (PISA) rankings, Thailand continued its decline, dropping to 55 out of 70 countries ranked (Thai PBS, 2016), from 50th in the 2012 results (OECD, 2012).

Additionally, even when Thai organizations administer Thai tests to Thai students, the results are the same or worse. In 2016, the yearly National Institute of Educational Testing Service (NIETS) O-NET (Ordinary National Educational Test) test result showed that out of 422,000 Grade 12 students tested, the average score for all students in eight subjects was under 50. For English and mathematics, the average scores were 24.98 and 26.59, respectively (Mala, 2016). This was consistent with the 2015 PISA academic evaluation scores, in which Thai students

were ranked only 54th in science and math, and 57th in reading, out of 70 countries tested (Rujivanarom, 2016). This was far behind the neighboring countries like Vietnam and Singapore.

For critical thinking, things are even worse. A Thailand Research Fund (TRF) study showed that Thai schools failed to foster critical thinking, analytical skills, and logic among students. This determination was based on results from testing of 2,901 Grade 6 students, 2,305 Grade 10 students, and 1,029 vocational students from 10 provinces. The PISA related test evaluated logical thinking and analytical skills, and the results revealed that the average score was just 36.5%, with just 2.09% of all students passing the exam (Rujivanarom, 2016).

Furthermore, in a 2014 analysis of Thailand's learning ability by Pearson's World Education, cognitive skills and educational attainment skills of Thai students were ranked 35th out of the 40 countries evaluated (Office of the Education Council, 2015). Further details from the study also indicated that lifelong learning skills and adults' cognitive skills declined rapidly when they were not used on a daily basis in their jobs. Further research also indicated that there is a strong correlation between the number of people in a country with basic cognitive skills, and the nation's labor productivity and economic growth (Molnar, 2014).

If one agrees with this, it appears that Thailand has a tall mountain to climb to reach the goals outlined in a recent national policy known as "Thailand 4.0," and the identified 10 economic sectors under it targeted for development (Jones & Pimdee, 2017). Thailand 4.0 is also an agenda and economic model based on creativity, innovation, new technology, and high-quality services (Bussi & Khatiwada, 2017) which is used to boost the quality of life.

Solutions?

Thailand's score results and abysmal rankings from the institutions mentioned above reflect the worrisome situation of the quality of education in Thailand. They reflect an environment which appears to be broken, with talk everywhere about the problem, but solutions about how to fix it few and far in between.

For many years now, however, the academic community and educational policymakers have embraced the ideas of teaching and learning in a 21st-century learning environment (Partnership for 21st Century Skills, n.d.). Reeve (2016) even outlined that is critical for Thailand's vocational education and training students (TVET). These included the 4Cs—critical thinking, communication, collaboration, and creativity.

As a foundation to the 4Cs however, we would like to suggest that the constructivist theory of learning, in which a student actively constructs new knowledge according to his/her existing knowledge, is a possible solution in raising scores and developing cognitive skills. Utilizing constructivist theory, a learner does not receive knowledge passively but instead interprets the knowledge received and then modifies the knowledge in a form acceptable to the learner (Ah-Nam & Osman, 2017). Also, the knowledge construction process can be improved through social interaction and discovery, with interactions between learners and teachers or more skillful classmates providing scaffolding to the learner. This occurs in what Vygotsky (1978) referred to as the zone of proximal development (ZPD). It is also believed that within this process, no interaction can be beneficial if the new information is presented to learners traditionally. The students should, therefore, be given the opportunity to explore or discover new knowledge, which according to Bruner (1966), learning and problem solving emerge out of an exploration of new knowledge.

As a new generation of technology emerged in the form of microcomputers, Papert (1980) *suggested that* children should use computers, as they are powerful tools in the creation of personal educational experiences. From his ideas, the term "constructionism**"** was created, as this was a process of "constructing," or "making." Papert's constructionism assumed an individual constructed one's knowledge, just like constructivism, which used code as a language to invent or to inquire. By inventing constructionism, Papert successfully predicted the use of technology, as seen in the current maker movement and increased use of programming in science labs to collect and analyze data. Papert's constructionism, therefore, allowed young learners to construct their knowledge of various subjects through personal inquiry and creativity.

The last pieces of the puzzle are now in our hands. Learning through the making of things is constructionism in action. Constructionism focuses on learners' participation, problem-solving, working

with others or as a team, providing the opportunity to choose what they are interested in, having alternatives to learn (learn how to learn), and opportunities to learn by taking action. The teacher's role is, therefore, to be facilitator, who helps learners move through a process together which focuses on how learners participate in the process of learning or planning (Rogers, 1999).

We, therefore, conceptualized the development of a constructionist learning management skill model for the vocational internship of student-teachers, by changing the teacher's role to be that of a facilitator. To learn this new role, teachers need to work in a team (Panich, 2012).

Research Objectives

The research study is rooted in a Thai university that produces teachers who teach in technical and vocational colleges, and its mission statement is to produce skilled workers who have the education and expertise to be a significant force in Thailand's labor market. As such, these Thai vocational education student-teachers are tasked through internships to go out and practice their knowledge and skills on future 21st century workers.

The CDCD (Create-Design-Construct-Develop) Model

The study's proposed CDCD model is a model based on the theory of constructionist learning. From the process of studying related theories, concepts, and

research related to constructionist theory, we developed a prototype model. All data gathered were synthesized as a prototype for the model. The details of the model were divided into four areas, which consisted of the learning process, learning activities, learning skills, and measurement and evaluation. The prototype was then turned over to seven experts for their consideration of the appropriateness of the model.

By using a focus group, the appropriate quality of the model's prototype was examined by seven experts who are authorities in constructionist theory, learning processes, learning management skills, and educational technologies. A primary focus of their comments concerning the prototype's model is the ability to suit the context of the country and its pedagogy in technical and vocational institutions in Thailand. After which, the data were analyzed using content analysis to verify the proposed constructionist learning skills model.

The outcome of this effort was the conceptualization and development of the CDCD Model (Figure 1). The heart of the constructionist theory is regardless of how the context changes, the core of the theory remains clear, which consists of create/think, design/plan, construct/make, reflection, show and share, and self-assessment/peer assessment. When applying to a new model of constructionist learning management skills model in the form of CDCD model, it consists of four steps: 1) learning to create, 2) learning to design, 3) learning to construct, and 4) learning to develop. The details of the model, such as meaning, keywords, and activities in each step are shown in Table 1.
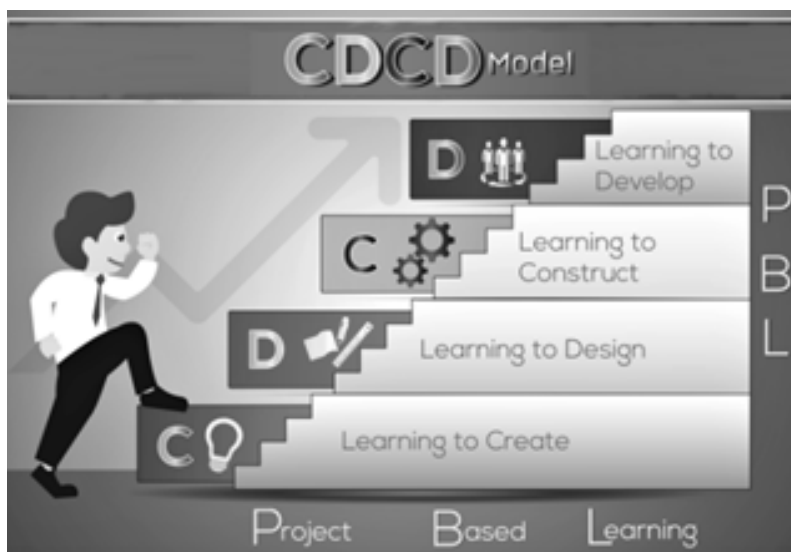
Figure 1. Constructionism learning skills model or CDCD model.

Table 1
The CDCD Model Details

	Meaning	Keywords	Activities	
			Teacher	Student
Create	Teacher introduces the activity to the students. Gathers their interests and creates a work project together. Sets the goals of the ideal work project. Teacher asks students to brainstorm and review their background knowledge.	*-Interest* *-Think* *-Idea* *-Create* *-Brainstorm* *-Discuss*	1. Introduce the activity. 2. Set the work project goal. 3. Form questions to stimulate students to think of their work project. 4. Ask students to brainstorm using their background knowledge. 5. Advise, stimulate, motivate, and facilitate the student's learning environment.	• Set their work project goal • Discuss in group • Brainstorm •
Design	The work project planning process involves students analyzing the background knowledge needed to get the work done. Students plan their own lessons and improve themselves. The criteria for their project's self-assessment is established and used after the activity.	-Plan -Design -Analyze -Search	1. Ask students to do a lesson plan or create their own work project. 2. Ask students to analyze their background knowledge and knowledge needed to get their work project done. 3. Tell students to search for additional information. 4. Tell the assessment criteria for their work project. 5. Observe, suggest, and facilitate.	• Plan a lesson and create the work project. • Analyze and review background knowledge and knowledge needed to get the work done. • Consider the criteria for the assessment to plan the creating of the work which goes accordingly.
Construct	Each work project is constructed according to a plan.	*-Construct product* *-Practice* *-Re-check Process*	1. Let students present their lesson plan and create their work projects. 2. Let students practice or construct their work according to a plan. 3. Observe, suggest, and facilitate.	• Present the lesson plan. • Act according to the plan. • Collect knowledge needed for the work project and make a report. • Check the process of constructing their work project.

| **Develop** | This process is how to made innovation work and in the process of knowledge, ideas, and self-development, present projects, sharing knowledge, reflecting ideas, and do self-assessment | *-New knowledge* *-New things* *-Presentation* *-Discussion* *-Reflection* *-Assessment* *-Improve themselves* *-Show & Share* | 1. Students practice how to present their new knowledge and share it with classmates. 2. Encourage students to comment on their classmates' work. 3. Let students evaluate according to the criteria. 4. Let students reflect on ideas about the activity of learning together. 5. Let students think of how to publish their work. 6. Observe, suggest, and facilitate. | • Present new projects/new knowledge/new things. • Exchange opinions about their classmate's presentation. • Evaluate themselves according to the criteria. • Reflect about knowledge gained by doing this activity. • Think further/ continue thinking/ enhance the ideas from the project. |

From these credible research studies, combined with teaching experience on constructionist theory, diffusion of this learning management skill through the CDCD Model can improve the learning skills of Thai vocational internship of student-teachers as well.

Using the constructionist learning theory adopted from the principals as outlined by Seymour Papert from the *Massachusetts Institute of Technology* (MIT), (Mayes, 1995). a new model was conceptualized which has been labeled as the "CDCD model." The learning skills that we need to develop from the use of CDCD model are: create, design, construct, develop, which are essential skills for learners in the 21st century.

Finally, we compared the result of CDCD model approaches and the PBL approaches. It aimed to find out whether a group of students learning with the CDCD model performed better than another group without it. We hope the CDCD model can be used to develop the four constructionist learning skills in Thai vocational internship of student-teachers. Finally, the internship of student-teachers who have been trained in the learning process using the CDCD model will be able to adapt and apply it in their teaching in the classroom and real situation.

Methods

Participants

Study participants were recruited from two classes of students registered in Computer Engineering and Electronics Engineering courses in semester 2 (2016) at the Faculty of Industrial Education and Technology at the King Mongkut's Institute of Technology Ladkrabang (KMITL), Bangkok, Thailand. A total 36 student-teacher interns participated in the study, from which 17 individuals were assigned to the experimental group and 19 individuals were assigned to the control group.

The students' instructor was a professor who had taught constructionist learning process history for more than 15 years. The experimental group students were taught using the CDCD model learning process, and the students in the control group were taught using the project-based learning (PBL) process. The role of the instructor as the facilitator of the learning process, who also monitored students' learning skills, solved any problems that arose, and assessed the students' learning skills. All lesson plans and classroom activities were new for this study and prepared by the instructor.

Procedure

The study was conducted for four weeks in which all participants first attended an hour-long familiarization

session to acquaint themselves with the new learning process. After which, each group was immersed for 30 hours in each learning process. The students could discuss ideas or tasks with team members to collaboratively complete the learning tasks. During the sessions, each student's teaching style was observed, and their advisor interviewed. At the end of the learning activities, the students completed a questionnaire and reflected on their learning experiences with the new learning process, and were asked to comment how the new teaching style was different from before.

Measurement

The assessment was divided into four sections: creation, design, construction, and development. There were three assessors for the study—an instructor and two teachers—who observed and evaluated (without participating) the four learning skills of the students. Each student was evaluated individually, with their classroom activities skills assessed. This included brainstorming, teamwork, presentation skills, discussions, reflections, and self-assessment. Assessors evaluated the students in four main skills (create, design, construct, develop), but in each category there were a total of 11 sub-skills. *Create* had three sub-skills, *design* had two sub-skills, *construct* had three sub-skills, and *develop* had three sub-skills. The evaluation criteria were divided into four increments that ranged from 1–4. Each level was clearly described in a scoring rubric.

Data Analysis

Normality testing is supplementary to the graphical assessment of normality, with the Kolmogorov-Smirnov (K-S) test and the Shapiro-Wilk statistical test being considered as useful tools for this process (Elliott & Woodward, 2007; Oztuna, Elhan, & Tuccar, 2006). The Shapiro-Wilk test measures the correlation between the data and the corresponding normal scores and is more powerful than the K-S test even after the Lilliefors correction (12). Some researchers recommend the Shapiro-Wilk test as the best test of the normality of data (Thode, 2002).

Additionally, the Mann-Whitney U non-parametric test was used to assess any significant differences. All statistical tests were computed using IBM SPSS Statistics for Windows, Version 20.0. A p-value of less than .05 was considered to be statistically significant. After the statistical analysis, a qualitative evaluation of each post-test was accomplished to examine the conceptual understanding of each learning skill.

Table 2
Kolmogorov-Smirnov and Shapiro-Wilk Statistical Testing

	Tests of Normality					
	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Think	.395	36	.000	.696	36	.000
Idea	.324	36	.000	.768	36	.000
Problem	.301	36	.000	.789	36	.000
Design	.288	36	.000	.795	36	.000
Plan	.313	36	.000	.780	36	.000
Making	.308	36	.000	.782	36	.000
PDCA	.333	36	.000	.752	36	.000
Present	.237	36	.000	.811	36	.000
Good-weak	.359	36	.000	.781	36	.000
Develop	.330	36	.000	.766	36	.000
Apply	.264	36	.000	.789	36	.000
Total	.148	36	.044	.926	36	.019

Results

Test Normal Distribution

Considering that the interval and ratio of data were so small, the initial analysis was conducted by relying on the output from the Kolmogorov-Smirnov and Shapiro-Wilk test statistics. The experiment's testing assumption is indicated as follows: H_0 = Normal Distribution, and H_1 = Skewed Distribution. The results showed that the significance of the Kolmogorov-Smirnov and Shapiro-Wilk test statistics at < .05. It is concluded from this that there is no normal distribution in such variable. The output data is presented in Table 2.

Table 3

The Type of Group, Participants, the Mean, and Summary for Each Group Ranking

Skill	Group	n	Mean	Sum
Create	E	17	25.88	440.0
	C	19	11.89	226.0
Think	E	17	22.50	382.50
	C	19	14.92	283.50
Idea	E	17	22.44	381.50
	C	19	14.97	284.50
Problem	E	17	22.21	377.50
	C	19	15.18	288.50
Skill	Group	n	Mean	Sum
Design	E	17	24.00	408.0
	C	19	13.58	258.0
Design	E	17	22.38	380.50
	C	19	15.03	285.50
Planning	E	17	21.97	373.50
	C	19	15.39	292.50
Construct	E	17	27.26	463.5
	C	19	10.66	202.5
Making	E	17	22.09	375.50
	C	19	15.29	290.50
PDCA	E	17	22.03	374.50
	C	19	15.34	291.50
Present	E	17	25.09	426.50
	C	19	12.61	239.50
Develop	E	17	23.41	398.0
	C	19	14.11	268.0
Good-weak	E	17	21.47	365.00
	C	19	15.84	301.00
Develop	E	17	23.03	391.50
	C	19	14.45	274.50
Apply	E	17	18.91	321.50
	C	19	18.13	344.50
Skill	Group	n	Mean	Sum
Total	E	17	28.00	476.00
	C	19	10.00	190.00

Note: E = experimental group, C = control group.

Difference of Mean Testing

Non-parametric statistics was used to conduct testing on both the experimental and control groups (Table 3) to determine which group achieved higher scores. The Mann-Whitney U test was additionally used in this process (Table 4).

The Mann-Whitney U test (Table 4) is a nonparametric method for detecting if two or more samples come from the same distribution, or to test if the medians between comparison groups are different (the assumption is that the underlying distributions are of the same shape). Thus, this nonparametric tests is used to determine if medians (not means) differ between comparison groups. SPSS provides the Kolmogorov-Smirnov (with Lilliefors correction) and the Shapiro-Wilk normality tests and prescribes these tests only for a sample size of less than 50, the primary reason for selecting these tests (Elliott & Woodward, 2007).

As such, the Mann-Whitney U test was used to statistically test the difference of the mean scores between the two groups—the experimental group who participated in the learning process using the CDCD model and the control group who participated in the learning process use of PBL. The findings showed that the experimental group obtained higher scores than the control group, which was significant at α = .05 level.

Furthermore, the Wilcoxon sign test was used as well, which is a close sibling of the dependent samples t-test. It is used when two measurements of the same dependent variable are taken at different time points or under different conditions for each subject, and the assumptions of the paired t-test have not been met (Corder & Foreman, 2014).

The Mann-Whitney U test was used to statistically test the difference of the mean scores for each type of skill between two groups. The findings showed that the experimental group had higher scores than the control group in each main category (skill, create, design, construct, and develop), which was significant at the .05 levels.

Asymp. Sig (2-tailed) is also applied when $n1 \geq 10$ and $n2 \geq 10$. It reconfirmed the experimental group had higher scores than the control group in other skills categories such as think, idea, problem, design, plan,

Table 4

Testing Two Independent Sample Groups with Mann-Whitney U and Wilcoxon W Test Statistics

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)	Exact Sig. [2* (1-tailed Sig.)]
Create	36.000	226.000	-4.161	.000	.000(a)
Think	93.500	283.500	-2.608	.009	.030(a)
Idea	94.500	284.500	-2.489	.013	.033(a)
Problem	98.500	288.500	-2.258	.024	.045(a)
Design	68.000	258.000	-3.158	.002	.002(a)
Design	95.500	285.500	-2.371	.018	.035(a)
Planning	102.500	292.500	-2.149	.032	.061(a)
Construct	12.500	202.500	-4.864	.000	.009(a)
Making	100.500	290.500	-2.191	.028	.052(a)
PDCA	101.500	291.500	-2.281	.023	.057(a)
Present	49.500	239.500	-3.831	.000	.000(a)
Develop	78.000	268.000	-2.768	.006	.007(a)
Good-weak	111.000	301.000	-1.881	.060	.114(a)
Develop	84.500	274.500	-2.818	.005	.013(a)
Apply	154.500	344.500	-.238	.812	.827(a)
Total	.000	190.000	-5.154	.000	.000(a)

Note. a. not corrected for ties. b. Grouping Variable: Groups

making, PDCA, present, and develop, which were all significant at the .05 level. However, there were two exceptions—good-weak and apply that showed no significance at the .05 level.

Discussion

Constructionism Learning Skills

The findings indicate that the proposed CDCD model is an effective tool for developing and improving constructionist learning skills. This finding is in accordance with multiple researchers and scholars concerning constructionism (Ayaz & Sekerci, 2015; Qarareh, 2016) and research concerning constructionist learning models (Stager, 2005; Triantafyllou & Timcenko, 2013).

Create

The result of the study indicated that the creation skill exhibited a significant difference between the two groups tested, as the CDCD students had statistically significant higher scores than the learners who participated in the control group using PBL learning processes (.05). It was also concluded that the CDCD learning model could develop creation skill in learners, which is consistent with the works of Papert (2001) about learning through projects and activities which can create imaginative ideas.

Additionally, the study was consistent with other researchers who concluded that constructionism methods help develop thinking skills (*Sirisopon & Sopeerak,* 2013), higher-order thinking skills such as problem-solving, critical thinking (Li, Cheng, & Liu, 2013), and creating (Deawwilai, 2007). In addition, Stager (2010) concluded that learner problems are not related to his training techniques, or ICT problems, or pedagogy, or their level of knowledge; but instead the problem is the power of thinking for the practice.

Design

Furthermore, study results for design indicated that designing and planning skills also had a significant difference between the two groups, with learners who were participants in the CDCD learning process having statistically significant higher scores than the learners who participated in the PBL learning process at the significant level of .05. It was, therefore, concluded that

the CDCD learning model could develop the design skills of learners.

Design skills can help develop and encourage learners to use teamwork on a project, which is an identified skill for a 21st century worker. After forming an idea of what they want to build, planning with clear procedures is the next step needed to achieve a practical purpose. This aspect supports students to be more creative, and also contributes to a project's teamwork process where students jointly create with their classmates and present their projects to the class (Bruckman, 1997) and planning skill (Deawwilai, 2007; Stager, 2010).

Construct

Learning by constructing, or learning by making new things, is the key to the constructionist learning process. The results of the study also indicated that constructing skills were significantly different between the two student groups, as the CDCD Model group showed better learning and work project building skills. Combined with the previous steps of thinking and design, this constructionist learning method can help develop learning (Alimisis, 2010; Deawwilai, 2007; Liu & Hsiao, 2002).

Develop

The results of the study also indicated that development skills were significantly different and at a higher statistical level (.05) between the two groups, with the CDCD model group learning better from their ability to develop projects. "Learning to develop" is about learners having a chance to show and share their ideas, after which they will receive comments and learn about their strengths and weaknesses. Most importantly, they can evaluate themselves and their team so they can achieve better results the next time. This is essentially in accordance with previous research which has produced similar results concerning constructionist learners having the ability to develop themselves (Deawwilai, 2007; Liu & Hsiao, 2002), improve their motivation to learn (Aweke, Ayele, & Zerihun, 2017), learn to accept their strength point and weak point, and apply to the real life (Deawwilai, 2007).

However, results determined that two skills—good-weak and apply—showed no difference between the

two groups at a significance level of .05. Reasons for this probably come from that the Thai culture has a limited ability to accept their own mistakes or weak points, and will always find ways to argue against any criticism and find the reasons to always support themselves.

This is supported by Barnes (2007), in which it was stated that due to the cultural factor he identified as *nisai* [habits/personality], criticism must be made in private, as public criticism causes discomfort and shame for an individual. Especially those who have not been taught and trained since they were young, they are not used to being open-minded in talking about bad and good points about oneself. Therefore, it is hard for them to listen to others talking about their own weak point.

Recommendations

The CDCD model has the potential to develop and improve learners' skills according to the theory. However, there is no clear difference between the experimental and controlled group of students in these two sub-aspects. First, is about accepting one self's strengths and weaknesses and second, is to apply it in daily life. It is suggested that future research focus in on the two sub-aspects, which need to strengthened concretely.

Also, field trips seem to be an ideal way to learn by using a constructionist learning method, as the experience is a first-hand experience, based in a real-world situation. The follow-up to such activity should include analysis and post-trip insight sharing. Moreover, they should be encouraged to apply their classroom theory into their real life. Results will not be instant, but with time, improvement of sub-skills will definitely be improved.

This model was developed for teachers to apply in their teaching. Teachers should be trained accordingly so that they can comprehend how to employ the model. This is to establish mutual understanding, opportunity to learn pros-and-cons, discover new techniques, and enjoy classroom atmosphere. Besides, teachers should be assisted with clear procedures, mentors, and training coaches throughout the duration of the training.

After the training sessions, there should be a follow-up procedure to evaluate how the model is applied. Education supervisor, school principals, academics affairs, teachers from various disciplines, parents, or other related parties, should be invited to participate in the observation of CDCD model. This is to point out the differences in the outcome between the results of the CDCD model and typical teaching methods.

After using the trial model (duration of 2 weeks or 1 month), teachers should be requested to deliver a presentation on how the model is applied to their teaching. Fellow teachers, principals, and relevant parties will learn the results of the model's outcomes, and exchange ideas and comments.

Future Research

Teachers should thoroughly study the outcome of each course and students' specific skills. The comparison should be made between the CDCD model-applied class and a typical teaching method class. This helps the teachers to reach more accurate and reliable outcomes.

The research presented the process for the development of a constructionist learning skills model for use by Thai vocational student-teachers interns.

Ethical clearance:

This study was approved by the institution.

Conflict of interest:

None.

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