To explore science, technology, engineering and mathematics （STEM） through into Massage therapy in a project-based learning (PjBL) environment

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Abstract

Traditional Taiwan's technological universities offer train regularly to the way they were trained decades ago, but rarely think how to develop cross-disciplinary problem solving skills in which become the gap between the technological university and the industry. This study is going to conduct the STEM education into a technological university in Taiwan, especially in the health-care department which students graduate will also participate in the health-care industry. The study examined a project-based learning (PjBL) activity that integrated STEM and multiple research methods were adopted. A sampling of 112 third-years of college students with health-care educational background was randomly selected from a technological university in Taiwan. Construct validity using factor analyses was established. The results found that PjBL can facilitate the enhancement of learners' positive attitudes towards STEM, particularly in the subjects of science and engineering; students indicated they preferred to learn the science knowledge related to practical experience, and agreed that science could be applied in daily life and is beneficial for our solution to reduce human disease. The study indicated the cross-disciplinary problem solving development via the PjBL activity within the STEM concepts increased students to practice the STEM knowledge efficiently.

Keywords: Project-based Larning (PjBL), STEM

Introduction

Traditional Taiwan’s technological universities offer train regularly to the way they were trained decades ago, but rarely think how to develop cross-disciplinary problem solving skills in

which become the gap between the technological university and the industry. This study is going to conduct the STEM education into a technological university in Taiwan, especially in the health-care department which students graduate will also participate in the health-care industry. How to teach students' divergent thinking, flexibility, and originality of cognitive processes is becoming the most crucial to their job ability.

According to the International Standard Classification of Education (UNESCO 1997) and Department for Innovation, Universities and Skills (DIUS) (2009a) which definition as used the life, health, physical, mathematical and engineering sciences, as well as STEM education systems, which focus on the chemistry, physics, mathematics and engineering; In deeper explaining, there is the categorization into the four STEM subject areas, such as "hard" science (physics and mathematics) and "soft" science (evolutionary biology, psychology, social science) (Pigliuicci, 2008).Although health-care industry attribution, this study is going to adopt the definition from the UNESCO and DISUS. That is possible both of health-care the same knowledge concepts, which relative the similar knowledge of the STEM "soft" science (evolutionary biology, psychology, social science).

Through integrating science, technology, engineering and mathematics into a project-based learning system, the students' reflection on their knowledge of STEM could help learners understand the relationship between their learning and problem-solving goals and could improve learning interest (Hmelo-Silver 2004; Salomon& Perkins 1989). STEM courses and programs are developed to generate meaningful learning through integrating knowledge, concepts and skills systematically that were the subjects of science, technology, engineering and mathematics are closely related to each other. (Seymour and Hewitt 2000; Singh et al. 2002), and the benefit of STEM is to enhance learning achievement, to improve learning attitudes and to increase continuity in learning (Springer et al. 1999).

In the beginning of Taiwan STEM education with regards to technological universities, more research should be done before the course designs. Thus, this study adopted an integrate STEM knowledge in project-based learning (PjBL) activity for students to see the four subjects of STEM education and improve their learning interesting; furthermore increase their problem solving skills and innovative, complicated solutions in preparing the 21st-century skills competition.

Literature Review

Taiwan's health-care industry

Taiwan's health-care is expected to register steady growth over the forecast period, with value sales at constant 2013 prices set to rise by a CAGR of 1%. In addition, the turnover of healthcare service industry in 2011 reached NTD 3.911 billion, which is also a 5.785% growth compared to the turnover of NTD 3.69 billion in 2010. From the above data, it is obvious to see that healthcare service industry has been constantly growing. According to 2010 study with 53 participants comparing the effects of one 45-minute Swedish massage to light touch, the massage had a large decrease in arginine-vasopressin, a hormone that normally increases with stress and aggressive behavior, and slightly lower levels of cortisol, a stress hormone, in their blood after the session.

As well, the crisis of civilization that reaches the most developed countries is reflected in the significant increase emotional and spiritual disease which is associated with imbalances and psychosomatic causes (stress, anxiety, and depression), physical inactivity, unhealthy eating habits, incorrect body posture. In nowadays the concerns of individuals with themselves and with their body and mind is related to disease prevention, the daily stresses and the importance given to

mental and psychological balance and to more hedonistic experiences of consumption of goods or services (McNeil and Ragins, 2005; Maket al., 2009). Research over the past couple of years has found that massage therapy boosts immune function in women with breast cancer, improves symptoms in children with asthma, and increases grip strength in patients with carpal tunnel syndrome. Giving massages to the littlest patients, premature babies, helped in the crucial task of gaining weight. The American College of Physicians and the American Pain Society now include massage as one of their recommendations for treating low back pain, according to guidelines published in 2007. The research is being driven, in part, by massage therapy's popularity. About 8.3% of American adults used massage in 2007, up from 5% in 2002, according to a National Health Statistics report that surveyed 23,393 adults in 2007 and 31,044 adults in 2002, the latest such data available. Massage was expected to be a $10 billion to $11 billion industry in 2011 in the U.S., according to estimates by the American Massage Therapy Association, a nonprofit professional organization.

In the 21st-century, skills are a growing interest in design thinking: an open-ended, nonlinear, and often messy way to generate innovation and creative solutions. In the health-care industry such as massage therapy, health-care designer, the hands-on, learning-by-doing experiences afforded by their senior manager implicitly require a design approach to problem solving. It should provide a deeper understanding skills, knowledge, and attitudes for massage therapy or health treatment process. How does health-care (massage therapy, health-care designer) need to implement their goal and core mission in the trend? For these purpose, Taiwan's technological universities have been focus on their students' skill development, in order to face global interconnection, technological advancement, and large-scale problem than ever before in human history, complex problems require sophisticated problem solving skills and innovative, complicated solutions.

Learning Attitude

In an early presentation by Myers (1993), three components of attitudes were formed: affect (emotion), relative to the feelings toward an object, cognition (knowledge), relative to the human belief about the object and intention (action), relative to the human manner toward the object (Hawkins, Best & Coney, 2004), which are influenced by various other attributes (Ajzen 2001; Crano and Prislin 2006). Several studies have provided support for the interrelated nature of these attitudinal components (Ajzen & Fishbein, 1980; Breckler & Wiggins, 1989; Miniard & Barone, 1997). Moreover, attitude is a result of learning and is strongly influenced by personal experience, family, friends and marketing (Eagly & Chaiken, 1993).

In the point of view of Osborne et al. (2003), student attitude towards enrolling in a course is a strong determinate of a student's choice in pursuing future careers. As a result, a better understanding of student attitude and the relationship between course choice and future career choice would lead to instructional and curricular changes that may support and enhance students' learning of difficult subjects such as science, technology, engineering and mathematics. This attitude appears prevalent and seems to permeate science achievement for many students in the U.S. These are needed to understand why students choose STEM majors and continue to pursue a career in STEM (Heilbronner, 2011).

STEM

Recently, there is increasing reliant on the Science, Technology, Engineering, and Mathematics (STEM) workforce to maintain leadership in the World economy (Banning & Folkestad, 2012).

‘‘As the world becomes increasingly technological, the value of these national assets will be determined in no small measure by the effectiveness of Science, Technology, Engineering, and Mathematics (STEM) education’’ (Holdren, Lander, & Varmus, 2010). STEM courses and programs are developed to generate meaningful learning through integrating knowledge, concepts and skills systematically. Students need to be involved in hands-on STEM activities to make the connection between education and future careers (McCrea, 2010). One longitudinal study that followed participants’ career choices in addition to their career aspirations found that learning experiences, such as perceived ability in mathematics and science had the greatest impact on their actual career choice (Garg, Kauppi, Urajnik, & Lewko, 2007).

STEM courses are often viewed as difficult and sometimes unrelated to reality. Some studies argued that Students choose not to complete STEM degrees for numerous reasons including uninspiring introductory courses or the lack of preparation and support to complete mathematics courses (Holdren & Lander, 2012). However, studies have demonstrated that as the percentage of female faculty in STEM departments increases, the percentage of four-year degrees awarded to females in these departments will also increase (Qian, Zafar, & Xie, 2009). For the science view that mentioned about students’ attitude was influenced by their emotion and interesting. (Mamlok-Naaman et al., 2005) As this result, that indicated the curricula focus more theoretical understanding than the practical work, which made students feeling boring during the class, also reduces their sciences experience. Some reports also suggested that students will have more interests to learn sciences in a practical way within enhance students’ personal autonomy (Osborne and Collins, 2000). In the technological of view, a basic hand-on capability was related;
Students would possess knowledge, way of thinking and acting within the technology found in their environments. (Pearson & Young, 2002) In the worldwide the students prefer to work with new technologies. (Jenkins, 2006) On the students’ attitude toward the engineers, engineering is considered more object-oriented than people-oriented (Malcom, 2008). As a result, many students who are interested in careers related to helping people may not pursue engineering-related or technology-related fields, because of the decrease of interests in science, which is based knowledge for learning engineering, another major reason for attracting students to consider engineering which would be a useful and interest attribution (Seymour & Hewitt, 2000).

On the other hand, a solid foundation in mathematics in early education is a difficult subject for students, also is critical to a student’s success in higher level science and mathematics coursework in high school. This is essential for college-bound students, particularly those interested in majoring in STEM disciplines (Nicholls et al., 2010 and Tyson, 2011). Although mathematics is one pillar of STEM education, it is arguably the most important because its concepts and methodologies pervade many science, technology, and engineering disciplines (National Research Council, 2011). In the study by Porter et al. (2006), an innovative system of STEM education for universities is proposed; they argued that through a system of multidisciplinary teaching, students may learn faster. Relevant research in Taiwan is only at the infant stage. More research is needed to investigate the impact of the integration of these subjects on the learning attitudes of students, and to provide reference to subsequent course design.

Project-based learning (PjBL)

Project-based learning mainly process include the construction knowledge by definition of new understandings or skills, decision-making, problem-finding, problem-solving, discovery, or model-building procedures (Bereiter & Scardamalia,1999).Through practical activities, interactive discussions, independent operation or team cooperation, students achieve their goal and establish

their own know-how. Bell (2010) states that project based learning (PjBL) process focuses on self-learning in an empirical project and students become better researchers, problem solvers, and higher-order thinkers. Kloppenborg and Baucus (2004) reiterate that many of skills learned through PjBL are highly sought by today's employers including the ability to work well with others and handle interpersonal conflicts, make thoughtful decisions, practice and solve complex problems.

Although, this study was through integrating science, technology, engineering and mathematics into a project-based learning procedure, that students were more willing to learn science knowledge via practical methods. Through this process, students' reflection on their knowledge of STEM could help learners understand the relationship between their learning and problem-solving goals and could also improve the ability to resolve conflicts through creative problem solving approaches and the accomplishment of a project that make them more aware of real life problems and issue. (Hmelo-silver 2004; Salomon & Perkins 1989). Therefore, PjBL plays a significant role in exposing students to a meaningful learning process while they are engaged in completing their project.

Methodology

The purpose of this study was to understand students' learning attitudes towards science, technology, engineering and mathematics through into the project-based learning (PjBL). This study employed the case study method, with students who participated in body and facial practical massage therapy skill program from the health-care department of a Taiwan Technology University. In order to integrate STEM, the design of the massage therapy project of Health-care include multi-disciplinary components of physiology, biology, psychology, social science, chemistry, facial skill program, body massage program, consumer psychology, service marketing management, salon business management, mathematic, customer behavior, application of Chinese medicine, application and practice of Aroma therapy, etc., which were related to the curricula that students had learned from a technological university.

The goal for the PjBL (massage therapy of Health-care project) in this study provided an opportunity for the participating students to learn through group effort, group discussion and the STEM system developed includes communication skills, autonomy, and self-monitoring which teach students to see problems as opportunity encourage them interaction among team work for creative problem solving. Multiple research methods were adopted, including: literature review, questionnaire and development of integrated STEM's teaching materials and project-based learning (PjBL) activity to explore the research subjects. A sampling of 112 third-years of college students with health-care educational background was randomly selected from a technological university in Taiwan. Construct validity using factor analyses was established. In massage therapy of Health-care project, students were encouraged to resolve problems with scientific and mathematical methods towards the purposely structuring their knowledge base. Students could also combine technological tools with engineering concepts to accomplish the project. The project-based learning procedure students used through integration science, technology, engineering and mathematics to see how to assist their effective learning attitude and motivation, also to enhance their ability for learning situation.

Results and Discussion

The results of the survey showed the overall reliability of questionnaire is high (Cronbach's α=0.879), and the reliabilities of the dimensions of science (S), technology (T),

engineering (E) and mathematics (M) are 0.708, 0.815, 0.806, 0.836, respectively. Also found that students' attitudes toward the subjects of sciences and engineering changed significantly. As results, students had a positive attitude towards STEM. According to Table1, descriptive statistics (mean, standard deviation) and one sample t test were adopted to investigate student's learning attitudes after participating in the STEM project activity.

To evaluate the student's learning attitudes, a five-point Likert scale was employed: 1 (strongly disagree) to 5 (strongly agree). The results found that student attitudes towards the four subjects of STEM were positive and significant (M=3.421, SD=0.327, t=110.837, sig=0.001). In particular, students had the most positive attitude toward engineering at the pre-test stage (M=3.606). The results have changed by the post-test stage in that science and engineering became the most popular subjects (M=3.404 & M=3.778). In addition that mathematics was the least popular subject at both pre-and post-test stages.

All in all, engineering is the most popular subject at the pre-learning stage, while science and engineering was recognized as the most popular subject after learning. The Paired-Sample t-test was adopted to measure the change of students' attitude towards STEM in this study. The results indicated that student had significant change in the attitude toward learning science and engineering (Pairs difference M_{post}-M_{pre}=0.151 & 0.172, t=3.866&3.556, sig=0.001). Regards to the technology and mathematics, students' positive attitudes increased slightly, although the changes were not significant, in term of the total four subjects students had a positive attitude changed (Pairs differences M_{post}-M_{pre}=0.105, t=3.270, sig=0.001).

Table1: Analysis of one-sample t test regarding students' learning attitude towards STEM

Anticipant	No.	Subject	Post-test			Pre-test			Pairs Differences		
			Mean	SD	t	Mean	SD	t	Mean	SD	t
Students	112	Science	3.404	.455	79.201***	3.253	.422	81.506***	.151	0.413	3.866 ***
		Engineering	3.778	.484	82.608***	3.606	.491	77.687***	.172	0.511	3.556***
		Technology	3.526	.571	65.372***	3.453	.505	72.274***	.073	0.769	.998
		Mathematics	2.977	.676	46.577***	2.953	.622	81.506***	.024	0.896	.281
		4 subjects	3.421	.327	110.837***	3.316	.364	96.408***	.105	0.339	3.270***

*p\0.05, **p\0.01, ***p\0.001

In addition due to the quantitative data, the students attitudes were positive and significant on the learning more science classes at both post-test (M=3.661), pre-test (M=3.473), and Pairs difference (M_{post}-M_{pre}=0.188, sig=0.029). Those data indicated "the experiment and observation are the important resource on science information and knowledge" post-test(M=3.938), pre-test (M=3.839) and Pairs differences (M_{post}-M_{pre}=0.98, sig=0.299), another is that " the science could help the humans solve the life's problems" pro-test (M=3.955), pre-test (M=3.821) and Pairs differences (Mpost-Mpre=0.134, sig=0.163). And also indicated "students have high expected in learning science with doing practical work. They mentioned they preferred to learn the science knowledge related to practical experience, and agreed that science could be applied in daily life and is beneficial for our solution to reduce human disease. In order to encourage the students'

motivation within the sciences knowledge this study using the PjBL strategy.

The finding is consistent with the findings of Osborne and Collins (2000) who discussed that students' personal autonomy and interest were enhanced via a practical method. They also supposed students were more motivated to learn within PjBL strategy. Please to see the table 2.

Table 2: The difference data for student's attitude on learning science

Questionnaire items	Post-test			Pre-test			Pairs Differences		
	Mean	SD	t	Mean	SD	t	Mean	SD	t (sig)
2: Experiments and observations are an important source of access to scientific Information and knowledge.	3.938	0.726	47.09	3.839	0.754	53.89	0.098	0.995	1.044 (0.299)
3: Science can help us to solve problems in the life.	3.955	0.728	57.52	3.821	0.750	53.93	0.134	1.009	1.405 (0.163)
4: I am willing to learn some science knowledge.	3.661	0.823	47.10	3.473	0.870	42.27	0.188	0.896	2.215* (0.029)

*p\0.05

Considering technology, students had the positive results in their questionnaire results, they indicated that "the technology can make things better" pro-test (M=3.929), pre-test (M=3.804) and Pairs difference (M_{post}-M_{pre}=0.125, sig=0.191), "solve the problems in life" pro-test (M=3.893), pre-test (M=3.857) and Pairs difference (M_{post}-M_{pre}=0.36, sig=0.729). They were "more willing to learn science and technology knowledge and ability" pro-test (M=3.625), pre-test (M=3.518) and Pairs difference (M_{post}-M_{pre}=0.107, sig=0.348). Similar results can regard to Jenkins (2006) said that students' identified the technology and science were important to health, life, and society. However, in the table 1 the students had a only slight increase among the STEM feedback which may be due to the fact that students would like to have more technology-related knowledge at school, as the female position they had less chance to operate the technology and had no chance to see the interrelationship of STEM theory into the practical hand-on activity. After through this PjBL activity, students achieved the STEM disciplines comprehensively which means the PjBL activity within the STEM concepts increased students to practice the STEM knowledge efficiently. Please to see the table 3.

Table 3: The difference data for student's attitude on technology

Questionnaire subject	Post-test			Pre-test			Pairs Differences		
	Mean	SD	t	Mean	SD	t	M	SD	t(sig)
20: Technology can make things better.	3.929	0.719	57.80	3.804	0.682	58.99	0.125	1.006	1.315 (0.191)
22: Technology can help us solve problems in life.	3.893	0.775	53.14	3.857	0.758	53.88	0.36	1.090	0.347 (0.729)
25: I am willing to learn some science and technology knowledge and ability.	3.625	0.912	42.08	3.518	0.827	45.00	0.107	1.203	0.942 (0.348)

*p\0.05

For engineering, regarding quantitative data indicated "They feel health treatments (Engineering) is workable" post-test (M=3.616) and pre-test (M=3.411) with pairs difference (M=0.205, sig=0.068), the students provide more positive feedback on health treatment course

(Engineering). Students believe the engineering is the application of scientific principle and can develop problem solving skills, they are more willing to learn new and advanced health treatments courses (Engineering). They mentioned "Health care training course curriculum can help us solve problems in life" post-test (M=4.027) pre-test (M=3.848) and with pairs difference (M_{post}-M_{pre} =0.179, sig=0.023). During the PjBL activity, students applied the conceptual knowledge of STEM, particularly in engineering knowledge. As that indicated " I am willing to learn more knowledge of health treatments" (Engineering) post-test (M=4.098) pre-test (M=3.875) and with pairs difference (M_{post}-M_{pre} = 0.223, sig=0.011), as well as " I have confidence in learning advanced health treatments courses" (Engineering) pre-test (M=3.500) and post-test (M=3.696) with pairs difference (M_{post}-M_{pre} =0.196, sig=0.024). Please to see the table 4.

Table 4: The difference data for student's attitude on learning health treatment process (Engineering)

Questionnaire subject	Post-test			Pre-test			Pairs Differences		
	Mean	SD	t	Mean	SD	t	Mean	SD	t (sig)
13: Health care training course curriculum can help us solve problems in life.	4.027	.636	66.99	3.848	0.725	56.13	0.179	0.819	2.308* (0.023)
14: I am willing to learn more knowledge of health treatments.	4.098	.697	62.23	3.875	0.861	47.64	0.223	0.917	2.575* (0.011)
15: I feel health treatments are workable.	3.616	.942	40.63	3.411	0.926	38.99	0.205	1.179	1.843 (0.068)
16: I have confidence in learning advanced health treatments courses.	3.696	.721	54.27	3.500	0.771	48.03	0.196	0.909	2.287* (0.024)

*p\0.05

In regard to mathematics, quantitative results indicated that students had negative results related to mathematics. Students mentioned they had difficulty to learn mathematic since in their earlier education from school, they dislike this subject not only hard to understand comprehensively but also is more theoretical and use less subject. The results found that applied STEM through into PjBL activity can facilitate the enhancement of learners' positive attitudes towards STEM, particularly in the subjects of science and engineering. This study program the educators design the appropriate PjBL's teaching strategy to raise students' learning interest and positive attitude (see Table 5).

First, educator indicated that ''science knowledge was mainly applied to the treatment plan of massage therapy of Health-care project, such as: the types of difference skin's function, structure, problems, and characteristics''. Also, ''concepts of science we are using the electrotherapy for skin-care and the knowledge and concepts of materials for different skin-care types requirements ''. Regarding the use of technology knowledge, educator ''applied technology knowledge related to the high-frequency machine was used as the major proceeding for treating skin diseases '' at the same time also ''used the knowledge of technology to use the wood's lamp to ensure the skin problem and facial vaporizer to make the skin more clean ''. Furthermore, the engineering related knowledge ''To Customize treatment through the skin characteristics by combining the high-frequency machine and functional materiel are applied to repair and recover the skin condition.'' Finally, educator also mentioned that ''applied mathematics knowledge in engineering and technology to figure out designs and solve problems in an interrelationship of business cost and customer satisfaction".

Figure 1 indicated the design and procedure of the massage therapy of Health-care project through integrating STEM related knowledge.

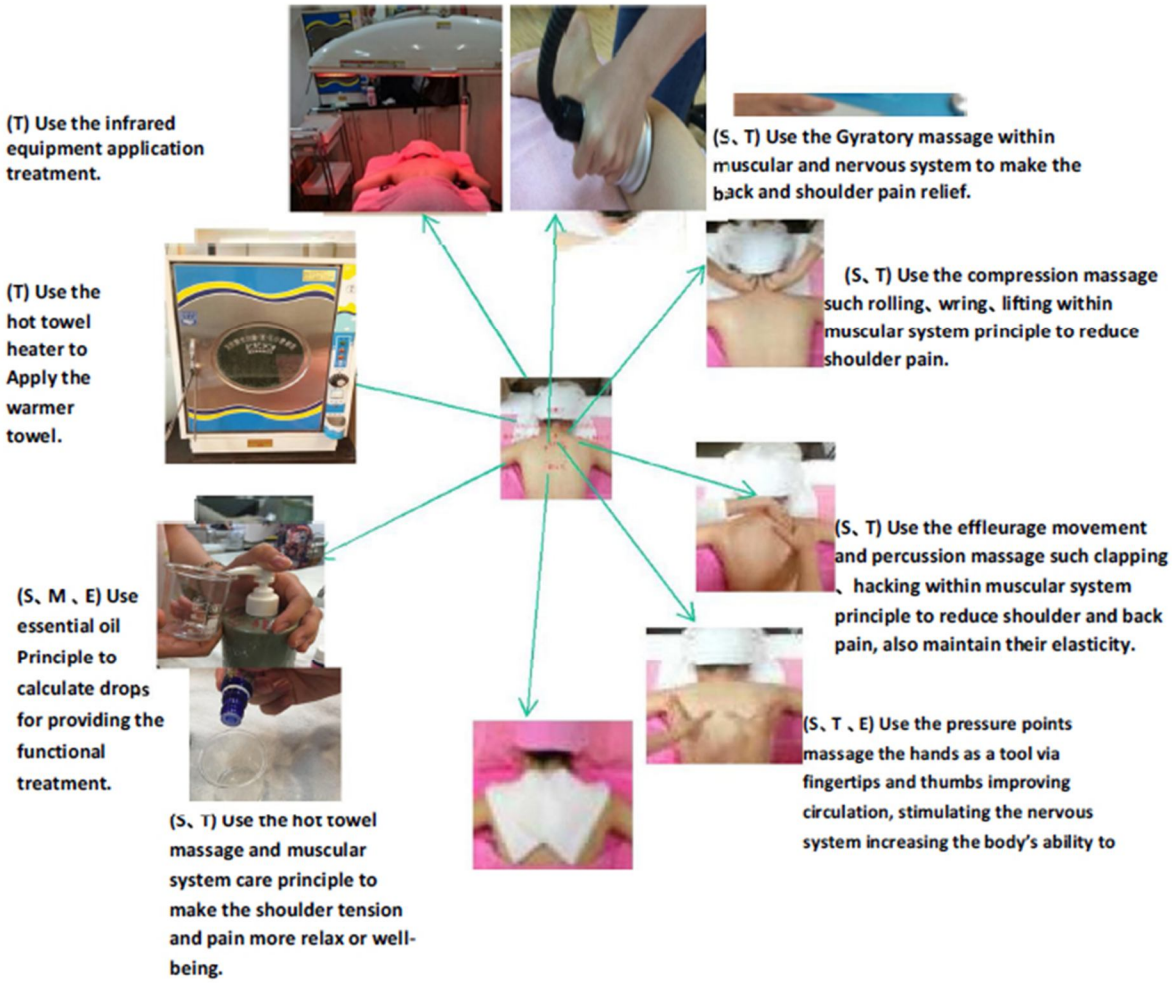

Fig. 1 The back and shoulder problem (massage therapy of Health-care project) that integrating STEM related knowledge.

Table 5 The description of student designing massage therapy of Health-care project through applying STEM knowledge

Problem	Science/mathematics	Technology	Engineering
 	1. The back and shoulder pain is constructed by the muscular system and nervous system. Before massage therapy, the skeletal and muscular and nervous was figured out. 2. The material is combined essential oil and based oil. The function of oil was also affected in order to release that tension and pain. 3. To calculated the oil drops and percentage to fit the body needs.	1. Adopting the manual massage; mechanical massage. 2. To apply massage techniques Such as effleurage, compression, percussion, vibration, frictions, pressure points. 3. Perform mechanical massage G5 machine. 4. To apply the infrared, steam, hot towels treatment.	1. To defined the back and shoulders treatment aims . 2. To select the right essential oil: lavender oil, peppermint oil, orang oil to fix pain. 3. To prepare 20ml based oil combined essential oil. 4. Adopting the shoulder's massage need essential oil for 5 that integrating STEM related knowledge of essential oil requirement for the body massage. 5. 1ml =20 drops oil, 20*20=400drops , 400d*5%/100%=20 drops.(total drops for essential oil) 6. To performance the pressure points massage use deep effleurage movement. 7. Applying the hot towels for the areas relax after deep massage .8. Release the pain.

Conclusion

The application of this PjBL activity that integrated STEM, students' attitudes toward the subjects of sciences and engineering changed significantly. As results, students had a positive attitude towards STEM. The effectiveness of PjBL on STEM subjects after students implemented PjBL, the most effective subject is engineering, the second is technology, the third is science, and the least is mathematics. A develop cross-disciplinary problem solving curriculum within applied STEM through into PjBL could increase effectiveness and meaningful learning for our students. A curriculum through this multidisciplinary teaching system, students of health-care department were more willing to learn STEM via PjBL practical methods. Such as students mentioned "I have confidence in learning advanced health treatments courses" They mentioned they preferred t o learn the science knowledge related to practical experience, and agreed that science could be applied in daily life and is beneficial for our solution of real life problems.

In the other side for the negative attitude of mathematic that might be this subject is time consuming and difficult to learn which make students to work insufficiently compare to the other

subjects of STEM. The finding suggested teaching strategy could involve interaction with the future career needs such as the benefit and cost between the customer and business to increase the needs for students' learning procedure. The discovery from study also showed that students have a good understanding to see the important learning style of cross-disciplinary that integrating STEM through into PjBL activity and influence students in future career pursuit. As the result, the study suggested that educator might be able to encourage our students start with the experiential learning and engage the students' interesting in a multidimensional process and stimulate them by making a teaching strategy combine PjBL with STEM to improve students essential competition and comprehensive ability.

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