Journal of Research and Curriculum Development, Vol.13, Issue.2, July – December, 2023
ISSN: 2730-387X (Online) https://so03.tci-thaijo.org/index.php/jrcd/index

The development of chemistry instructional handbook by blended learning to enhance achievement on chemistry and science process skill for vocational certificate (skill bridging program) of Polytechnic Institute of Banteay Meanchey Province, Kingdom of Cambodia

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Received: May 4, 2023
Revised: June 26, 2023
Accepted: June 28, 2023

Abstract: The research objectives are as follows: (1) to develop an instructional chemistry handbook by blended learning for skill bridging program of the Polytechnic Institute of Banteay Meanchey Province in the Kingdom of Cambodia; (2) to study science process skills among students who learned with chemistry instructional handbook on blended learning; (3) to compare achievement on chemistry learning before and after learning with an instructional chemistry handbook on blended learning; (4) to study the satisfaction of teachers who used an instructional chemistry handbook of blended learning. The 40 samples were vocational certificate students and two teachers from a Polytechnic Institute of Banteay Meanchey Province, using sample and random sampling. The implement lasted for seven weeks. The data were statistically analyzed using mean, standard deviation, and a dependent t-test. The instruments used for gathering the data were as follows: (1) the chemistry instructional handbook by blended learning; (2) science process skill test; (3) pretest and posttest; and (4) teacher satisfaction. The research findings were as follows: (1) the result of the instructional chemistry handbook on blended learning and had 10 components; (2) the results of studying science process skill of the students who learned with instructional chemistry handbook by blended learning. In Unit One, science process skills were moderate ($\overline{X}$=3.30, S.D.=0.55), in Unit Two of an science process skill were high ($\overline{X}$=3.51, S.D.=0.50); in terms of Unit Three, science process skill were high ($\overline{X}$=3.75, S.D.=0.54), in Unit Four, the science process skill were high ($\overline{X}$=4.10, S.D.=0.50), which accepted the research hypothesis; (3) the result of comparison of achievement on chemistry learning before and after learning with instructional chemistry handbook on blended learning are difference levels of statistical significance of .05; (4) the result of studying teacher satisfaction with an instructional chemistry handbook on blended learning was at a level of "high".

Keywords: Blended learning, Achievement, Science process skill, Chemistry instructional handbook

Introduction

In this century, education has changed and studying in class is not fixed for students because the world we live in is one that is heavily reliant on technology and media, characterized by easy access to a wealth of information, rapid advancements in technological tools, and the capacity for unprecedented levels of collaboration and individual contribution. The 4Cs of learning and innovation distinguish students who are prepared for the increasingly complicated work and living contexts of the current area and have information about critical thinking, problem-solving, collaboration, creativity, and innovation (Joseph, 2016). Science education is very important and one of the science subjects taught in schools is chemistry. Skill-bridging programs have many unpredicted possible benefits for the future. Chemistry is the study of matter and the properties related to physical, chemical and energy changes, therefore making it possible for students to apply their knowledge and skills to address issues in daily life, which is one of the goals of teaching chemistry. The strategies and tactics teachers use to determine whether or not this goal is accomplished. This approach may either increase or decrease the student interest in the material and have an impact on

how well they learn in general (Chebii, 2008). The problem of achievement in chemistry in the Polytechnic Institute of Banteay Meanchey Province, the learner does not understand, had low scores because the media was not interesting or outdated did not support and the handbook linked with blended learning. Also, science learning needed to use interesting media, blended learning and the handbook together. According to the Kenya National Examinations Council (KNEC), secondary school pupils scored poorly on chemistry practical exams, which had an impact on their total chemistry results. The strategies teachers employ may contribute to the poor performances of students in chemistry (Chebii, 2008). Daniellé (2017) defined a handbook is the document that provides knowledge related to the users by managing the matter by themselves, and achieve the same rhythm. The science process skills and academic accomplishment of students involved a plant tissue culture course and can be improved through the use of blended learning. This is because it offers a variety of educational tools, including photographs, animation, movies, writings, pictures, chat rooms, and more. Students start interacting because of this, due to the fact that they can access and participate in their educational program at any time and from any location. In this way, blended learning offers students a singularly adaptable learning experience. In order to actively participate in their studies. The participants did not have to be on campus. In a blended learning environment and learners had access to a variety of learning resources to boost their confidence and competence. They also receive feedback quickly and will aid them in their learning process, are freed from the limitations of traditional training, and can choose when and where to complete their training. Additionally, the students were more accountable for their education and motivation. Through interactive sessions, blended learning offers collaborative activities between teachers and students that will enhance student happiness and academic success. Give everyone who needs training access by making it available in many ways (Khan et al., 2012). Abungu, H. E., Okere, M. I. O., & Samuel Wachanga, W. (2014) research about the effect of science process skills teaching approach of the achievement of secondary school students in chemistry in Nyando District, Kenya. The findings showed that SPSTA significantly impacted student perception of their own abilities in chemistry. The findings of this study could help educators create instructional strategies that improve the perceptions of students themselves as chemists and help chemistry be taught and learned more effectively in Kenyan secondary schools. Feyzioglu, B., Demirdag, B., Akyildiz, M., & Altun, E. (2012) on the validity and reliability of a science process skills test for secondary pupils. The reliability and the validity of the test were validated by the findings of the confirmatory factor analysis. According to Policy of Polytechnic Institute of Banteay Meanchey Province is following by policy of Technical Vocational Education and Training (TVET) (Sub-Degree No.175/KB.BrKBB dated 20 April 2017 of MLVT, 2017). This depends on the learner and the skill-bridging program at the Polytechnic Institute of Banteay Meanchey Province in Cambodia. It was found that the problem of tandem of non-achievement examination, instruction, motivation, observation, testing, and identifying problems in the classroom. This was especially true of chemistry, the learners lacked satisfaction to study, with technology or media in teaching and learning, making relationships closer, motivation to study, discipline, and most of the learners stopped studying for a long time.

In total, their problems in class led to technology-based education to solve the problem with blended learning. In blended learning, which uses a computer, the internet, or a smart classroom, e-learning is included into traditional classroom instruction. The teacher met the students in person, and teacher-student interaction was incorporated into the course design (Kavitha & Jaisingh, 2018). Blended learning combines modern learning technology

with onsite teaching in the classroom, capable to save the time of teachers and students to make the learning process more effective and link it with the chemistry (vocational certificate) and studied for only 24 hours. Chemistry is crucial for giving all students a fair awareness of the world around them, enabling them to participate in social discussions about issues related to science and technology, as well as for providing employment prospects in the most efficient and comprehensive way feasible. The objectives of this research were to 1) To development the effectiveness of an instructional chemistry handbook by blended learning for the skill-bridging program at the Polytechnic Institute of Banteay Meanchey Province in the Kingdom of Cambodia. 2) To study the science process skills of students who learned with an instructional chemistry handbook by blended learning. 3) To compare achievement on chemistry learning before and after learning with an instructional chemistry handbook by blended learning. 4) To study teacher satisfaction with an instructional chemistry handbook with blended learning.

Research methodology

Step 1: To study the principle, concepts, theories, and research related to the instructional chemistry handbook by blended learning consisted of four sub-steps: 1.1. Analysis of previous research papers. 1.2. An analysis of the core curriculum chemistry of Grades Eight and Nine (skill bridging program). 1.3. To study the statement of the problems and needs of teachers and students in chemistry among Grades Eight and Nine (skill-bridging program) in PIBMC. 1.4. The interviews and observation by visiting best practice schools in Nakorn Pathom province and Bangkok, Thailand. The population of the study were seven secondary schools and two universities in Nakorn Pathom and Bangkok, Thailand. The sample consisted of secondary school schools (16 chemistry teachers) and two universities (chemistry professors) in Nakorn Pathom and Bangkok, Thailand using purposive sampling. The interview forms were distributed among secondary school (16 chemistry teachers) and two universities (two chemistry professors) and divided into two parts: (1) general questionnaire survey, such as gender, age, work/career, and the experience of chemistry teachers or professors; and (2) interviewing for opinions related to an instructional chemistry handbook by blended learning, such as the components of the handbook, the learning process, learning activities, instructional media, and assessment by structured interviews. The observation form for the secondary school (16 chemistry teachers) and two universities (two chemistry professors) and divided into two parts: (1) a general questionnaire survey on age, gender, work/career, and the experiences of chemistry teachers or professors; and Part Two, observations related with an instructional chemistry handbook by blended learning, such as the components of a handbook, learning process, learning activities, instructional media, and assessment by visiting best practice schools in order to find quality by index of item objective congruence (IOC). The index of item objective congruence (IOC) was used to evaluate the items of the questionnaire based on a score ranging from -1 to +1. Congruent = + 1 Questionable = 0 Incongruent = -1 the items that had scores lower than 0.5 and were revised. On the other hand, items with scores higher than or equal to 0.5 were reserved.

Step 2: the development of an instructional chemistry handbook by blended learning consisting of five sub-steps. 2.1. Development of an instructional chemistry handbook by blended learning for a vocational certificate (skill-bridging program) for Grade Eight and

Nine students. 2.2. Development assessment of achievement test, science process skills, and a teacher satisfaction form. 2.3. A focus group of seven experts revising the quality and making recommendations for an instructional chemistry handbook, an achievement test, a science process skills test, and a teacher satisfaction form. 2.4. To propose an instructional chemistry handbook by blended learning to advisor for considering and revising in accordance with recommendations. 2.5. Final revision of instructional chemistry handbook by blended learning.

Step 3: the implementation of an instructional chemistry handbook by blended learning to enhance achievement on chemistry and science process skills for vocational certificate (skill- bridging program) of the Polytechnic Institute of Banteay Meanchey Province in the Kingdom of Cambodia, consisting of two sub-steps: 3.1. training two chemistry teachers in the skill-bridging program (one week) in PIBMC. 3.2. Teaching 40 students in a skill-bridging program (Grade Eight and Nine) (seven weeks) in PIBMC. The samples of the research study were 40 students in Grades Eight and Nine and two teachers for the vocational certificate (skill-bridging program) of Polytechnic Institute of Banteay Meanchey Province. The instruments used to develop the instructional chemistry handbook by blended learning, including an interview form, observation form, a questionnaire for a focus group discussion, an instructional chemistry handbook by blended learning, a pretest and a posttest, science process skills, and teacher satisfaction. The data analysis consisted of average ($\overline{x}$), standard deviation (SD), a dependent t-test, and content analysis.

Step 4: to study the effectiveness of an instructional chemistry handbook by blended learning to enhance achievement of the chemistry and science process skills for a vocational certificate (skill-bridging program) at the Polytechnic Institute of Banteay Meanchey Province in the Kingdom of Cambodia. The researcher studied and analyzed previous research documents related to a teacher satisfaction form, creating a teacher satisfaction form, proposing a teacher satisfaction form to an advisor for considering and revising in accordance with recommendations. The teacher satisfaction form was revised by seven experts in terms of quality and recommendations for focus group discussions. The improved satisfaction of teacher forms followed expert recommendations. The modified teacher satisfaction form was used as instrument and then collected data based on recommendations for improvement. The teacher satisfaction form found a mean value ($\bar{x}$) and standard deviation (SD).

Research results

1. The result of the development of an instructional chemistry handbook by blended learning for a skill-bridging program at the Polytechnic Institute of Banteay Meanchey Province in the Kingdom of Cambodia.

After an analysis of a previous research paper, experts were interviewed and chemistry teachers had a focus group discussion, and observed chemistry instruction by visiting the best practice schools, located in Nakorn Pathom province and Bangkok, Thailand, and the use of instructional chemistry handbooks by blended learning to enhance achievement of chemistry and science process skills for a vocational certificate (skill-bridging program) of the Polytechnic Institute of Banteay Meanchey Province found that the components of instructional chemistry handbook by blended learning: (1) instruction; (2) content; (3) objectives; (4) learning process; (5) media/technology; (6) assessment and evaluation; (7) units; (8) the use of media and technology; (9) reference; and (10)

bibliography. The learning process of the instructional chemistry handbook by blended learning, consisting of seven steps.

1. Elicit: The instructor strives to get students interested in the topic and gauge their prior knowledge. The students were motivated by concept cartoons, video clips, animations, and straightforward scientific experiments.
2. Engage: To interest pupils and get their attention, teachers may conduct a basic experiment or point out an anomalous occurrence.
3. Explore: The questioning method is used to guide pupils as they examine and revise the material and by using brainstorming within the parameters of an activity linked to the subject, assumptions and hypotheses are established in order to direct students and record the data and utilizing worksheets.
4. Explain: Learning is interpreted by students. In addition to giving a direct lecture, a teacher may also use videos, movies, idea maps, or presentations to illustrate the theories, concepts, laws, and facts.
5. Elaborate: The use of understanding in new contexts encouraged the students.
6. Evaluate: Using multiple choice, quizzes, puzzles, structured grids, and true-false questions to assess their learning, in addition to formative and summative evaluation.
7. Extend: It is expected of students to apply and broaden their knowledge to situations in daily life.

The technology or media of an instructional chemistry handbook by blended learning, such as Facebook, YouTube, Google applications, such as Google Classroom, Google Forms, Google Meet, Kahoot app, PowerPoint, and PhET app. The learning assessment of instructional chemistry handbook by blended learning, such as a formative assessment (a pretest, worksheets, and science process skills (five skills), and class participation and a summative assessment (a posttest and a presentation). The blended learning was face to face (50%) and online (50%).

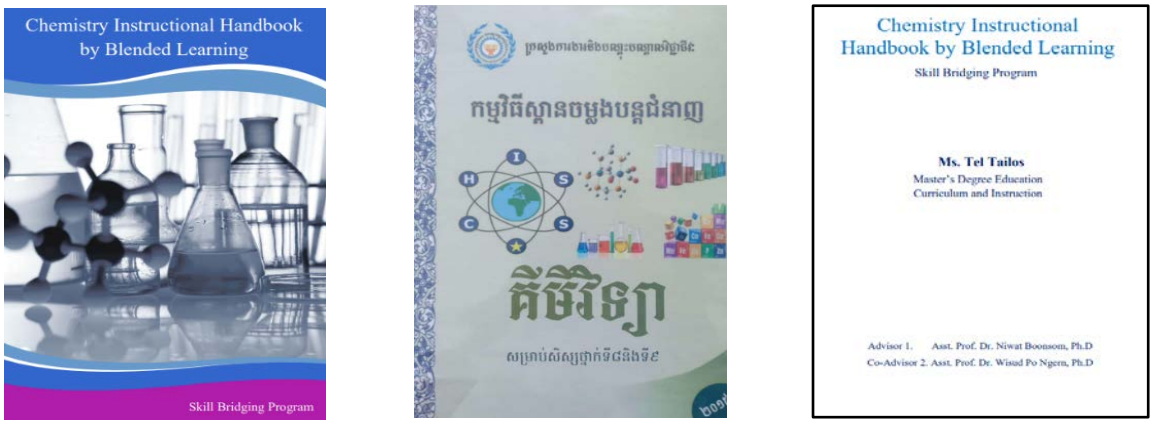

Figure 1 Instructional chemistry handbook by blended learning

2. The result of study science process skill of the students who learn with an instructional chemistry handbook by blended learning.

The researcher used the instructional chemistry handbook by blended learning to be implemented over seven weeks with the sample. The results of science process skills during use of an instructional chemistry handbook by blended learning to enhance achievement of chemistry and science process skills for a vocational certificate from the Polytechnic Institute of Banteay Meanchey Province.

Table 1. Overall results of science process skills during use of an instructional chemistry instructional handbook by blended learning

Science process skills	Unit1		Unit2		Unit3		Unit4	
	M	SD	M	SD	M	SD	M	SD
Observing	3.23	0.62	3.55	0.50	4.13	0.52	4.45	0.50
Measuring	3.20	0.56	3.55	0.50	3.75	0.49	4.20	0.41
Classifying	3.28	0.51	3.43	0.50	3.65	0.53	4.03	0.42
Predicting	3.33	0.53	3.50	0.51	3.55	0.50	3.95	0.50
Communicating	3.45	0.50	3.53	0.51	3.68	0.47	3.85	0.43
Overall	3.3	0.55	3.51	0.50	3.75	0.54	4.1	0.50

Table 2. Results of science-process skills during use of instructional chemistry handbook by blended learning (Unit 1)

Science process skill	M	SD	Interpretation
Observing	3.23	0.62	Moderate
Measuring	3.20	0.56	Moderate
Classifying	3.28	0.51	Moderate
Predicting	3.33	0.53	Moderate
Communicating	3.45	0.50	Moderate
Overall	3.30	0.55	Moderate

Table 2 found that the process skill scores of the students when using the instructional chemistry handbook by blended learning to enhance the chemistry and science achievement process skill for vocational certificates at the Polytechnic Institute of Banteay Meanchey Province. Overall, their science process skills were moderate (M=3.30, SD=0.55) which accepts with the research hypothesis. In unit 1, the mean of communicating wss higher (M=3.45, SD=0.50), predicting (M=3.33, SD=0.53), classifying (M =3.28, SD=0.51), observing (M=3.23, SD=0.62), and measuring have (M=3.20, SD=0.56) a moderate interpretation.

Table 3. Results of science process skills with the instructional chemistry handbook by blended learning (Unit 2)

Science process skills	M	SD	Interpretation
Observing	3.55	0.50	High
Measuring	3.55	0.50	High
Classifying	3.43	0.50	Moderate
Predicting	3.50	0.51	High
Communicating	3.53	0.51	High
Overall	3.51	0.50	High

According to Table 3, the scores of the process skills of the students using an instructional chemistry handbook by blended learning to enhance achievement on chemistry and science process skills for a vocational certificate of Polytechnic Institute of Banteay Meanchey Province. Overall, their science process skills were high (M=3.51, SD=0.50) which accepted the research hypothesis. In the Unit Two, the mean of observing was higher (M=3.55, SD=0.50) interpretation was high (M=3.55, SD=0.50) interpretation is high and communicating was (M=3.53, SD=0.50) interpretation was high, and predicting (M=3.50, SD=0.51) interpretation was high, and classifying was (M=3.43, SD=0.50) and interpretation was moderate.

Table 4. The result of science process skills using an instructional chemistry handbook by blended learning (Unit 3)

Science process skills	M	SD	Interpretation
Observing	4.13	0.52	High
Measuring	3.75	0.49	High
Classifying	3.65	0.53	High
Predicting	3.55	0.50	High
Communicating	3.68	0.47	High
Overall	3.75	0.54	High

According to table 4, the process skill scores of the students while using an instructional chemistry handbook by blended learning to enhance achievement on chemistry and science process skills for a vocational certificate of Polytechnic Institute of Banteay Meanchey Province. Overall, of science process skill are (M=3.75, SD=0.54) which accepts with the research hypothesis. In the Unit 3, the mean for observation was higher (M=4.13, SD=0.52), measuring has (M=3.75, SD=0.49), communicating (M=3.68, SD=0.47), classifying (M=3.65, SD=0.53) and predicting have (M=3.55, SD=0.50) interpretation all are high.

Table 5. The result of science process skill during used a chemistry instructional handbook by blended learning (Unit 4)

Science process skills	M	SD	Interpretation
Observing	4.45	0.50	High
Measuring	4.20	0.41	High
Classifying	4.03	0.42	High
Predicting	3.95	0.50	High
Communicating	3.85	0.43	High
Overall	4.10	0.50	High

According to table 5, the process skill scores of the students while using an instructional chemistry handbook by blended learning to enhance achievement on chemistry and science process skill for a vocational certificate at the Polytechnic Institute of Banteay Meanchey Province. Overall, the science process skills were as follows: (M=4.10, SD=0.50) which accepted the research hypothesis. In Unit 4, the mean of observation was higher (M=4.45, SD=0.50), measuring (M=4.20, SD=0.41), classifying (M=4.03, SD=0.42), predicting (M=3.95, SD=0.50), and communicating (M=3.85, SD=0.43) and interpretation were all high.

3. The results of the comparison of achievement on chemistry learning before and after learning with an instructional chemistry handbook by blended learning.

The results of using the instructional chemistry handbook by blended learning for vocational certificate with 40 students in the Polytechnic Institute of Banteay Meanchey Province in the Kingdom of Cambodia. It was found that students could perform activities in each teaching series as required. The most of students had interest in an instructional chemistry handbook by blended learning, such as learning using an application, YouTube, Phet, Kahoot, Google Classroom, and Telegram. All applications made the students understand the lesson more than before, consultations with teachers, observations and watching videos, playing games, and presentation.

Table 6. The results of the implementation of an instructional chemistry handbook by blended learning.

Lesson	The results in practical
1. Atoms and molecules	Teachers can teach according to the activities provided. The students watched videos at home as assigned by the teacher, observed and watched YouTube or video in the classroom, interest in Phet, and playing games with the Kahoot app. The problem was that students had difficulty using an educational app and media to finish the lesson.
2. Periodic Table	The teachers can teach according to the activities provided. The students were observed watching videos in the classroom, interested in the periodic table app, and playing games with the Kahoot.
3. The properties of matter	The teachers can teach according to the activities provided. The students and playing games with the Kahoot app, using the Phet app and YouTube. The problem was that the students did not understand. This allowed students to understand more and able to do the exercises on their own, explain again or give an example and the student review on the Phet app.
4. Classification of matter	The teachers can teach according to the activities provided. The students watched video from home as assigned by the teacher, playing games with the Kahoot app, watched YouTube in the classroom, and were interested in the Phet app.
5. The Properties of matter	The teachers can teach according to the activities provided. The students search for information at home and summarizing the results to present on the first page. The results showed that the students were able to present work at a good level and find information.
6. Chemical Reaction	The teachers can teach according to the activities provided and searched for information at home about chemical reactions, watched videos from home, as assigned by the teacher, and do the exercises.
7. Balancing Chemical Equations	The teachers can teach according to the activities provided. The students are searching for information at home about balancing chemical equations, watching videos from home as assigned by teachers, doing exercises, and balancing chemical equations on the Phet app. The students explain balancing chemicals with other friends in the classroom.
8. Solution	The teachers can teach according to the activities provided. The students watched videos from home as assigned by the teacher, interested in experiments, and summarized as the results of the experiments themselves.
9. Acids and Bases	The teachers using the activities provided. The students watched videos from home as assigned by the teacher, were interested with experiments, and summarized as the results of the experiments themselves. The results showed that the students were able to present work at a good level.
10. Salts	The teachers can teach according to the activities provided and students can search for information at home.

The researcher used the instructional chemistry handbook by blended learning to implement in seven weeks with the results of learning using the instructional chemistry handbook by blended learning. Table 7 compared the results before and after using an instructional chemistry handbook.

Table 7. Compare the results before and after use chemistry instructional handbook by blended learning

Test	Score	M	SD	t	P-value
Pretest	100	22.60	7.89	-42.151	.000
Posttest	100	79.15	8.08		

In Table 7, it was found that the average score of learning to use instructional chemistry handbook by blended learning to enhance achievement on chemistry and science process skills for a vocational certificate at the Polytechnic Institute of Banteay Meanchey Province that the posttest $(M = 79.15, SD = 8.08)$ was higher than pretest $(M = 22.60, SD = 7.89)$ with a level of statistical significance at .05.

4. The results of the satisfaction of teachers who use an instructional chemistry handbook by blended learning.

The researcher used the instructional chemistry handbook by blended learning to implement seven weeks with the sample as the result of teacher satisfaction who used a instructional chemistry handbook by blended learning to enhance achievement of chemistry and science process skills for a vocational certificate and the Polytechnic Institute in Banteay Meanchey Province.

Table 8. The results of teacher satisfaction with the instructional chemistry handbook by blended learning

Satisfaction issue	M	SD	Level
Objective of learning with an instructional chemistry handbook by blended learning	4.00	0.47	High
The content of an instructional chemistry handbook chemistry by blended learning	3.63	0.52	High
Role of teachers in chemistry using an instructional chemistry handbook by blended learning	4.00	0.00	High
Management of teaching chemistry with an instructional chemistry handbook by blended learning	3.83	0.41	High
The lesson of instructional chemistry handbook by blended learning	3.55	0.51	High
Type of instructional chemistry handbook by blended learning	3.92	0.29	High
Evaluation of the results of chemistry using instructional chemistry handbook	3.83	0.39	High
Total	3.79	0.44	High

According to Table 8, the satisfaction of the teachers with instructional chemistry handbook by blended learning to enhance achievement on chemistry and science process skill for vocational certificate of Polytechnic Institute of Banteay Meanchey Province. Overall, teacher satisfaction was at (M=3.79, SD=0.44), which conformed with the research hypothesis. The objective of learning chemistry and the roles of teachers in teaching chemistry with instructional chemistry handbook by blended learning were higher (M=4.00, SD=0.00), and the type of instructional chemistry handbook was (M=3.92, SD=0.29), management of teaching chemistry subject using chemistry instructional handbook by

blended learning and evaluation the results of the use of the instructional chemistry handbook by blended learning was (M=3.83, SD=0.39), the content of the instructional chemistry handbook by blended learning was (M=3.63, SD=0.52), and the lesson of the instructional chemistry handbook by blended learning was (M=3.55, SD=0.51), and interpretation were all high.

Discussion

According to the research, the development of an instructional chemistry handbook by blended learning to enhance achievement on chemistry and science process skill for vocational certificate (skill-bridging program) at the Polytechnic Institute of Banteay Meanchey Province in the Kingdom of Cambodia. The researchers discussed and detailed the results, as follows:

1. The results of the development of the instructional chemistry handbook by blended learning to enhance achievement on chemistry and science process skills for a vocational certificate (skill-bridging program) of Polytechnic Institute of Banteay Meanchey Province. It was found that an instructional chemistry handbook by blended learning consisted of instruction, content, objective, learning process, media/technology, assessment and evaluation, units, media and technology, reference, and bibliography. The instructional chemistry handbook by blended learning had seven steps: (1) elicit; (2) engage; (3) explore; (4) explain; (5) elaborate; (6) evaluate; and (7) extend. The technology or media of chemistry instructional handbook by blended learning as; Facebook, YouTube, Google application (such as Google Classroom, Google Forms, and Google Meet), Kahoot app, PowerPoint, PhET app. The learning assessment was an instructional chemistry handbook by blended learning as a formative assessment (pretest, worksheets, and science process skills (five skills), and class participation and a summative assessment (posttest). It was organized in a systematic and step-by-step way, based on the theory of creating a collection of mixed media teaching, a lecturer who was a thesis advisor, expert and to test the students. It was accepted with a research hypothesis.

The researcher created chemistry instructional handbook by blended learning through study curriculum of chemistry in Grade 8 and Grade 9 (skill-bridging program) of the Polytechnic Institute of Banteay Meanchey Province, needed students and teachers to create an instructional chemistry handbook for process creating, and developed a need through a step-by-step process that make chemistry instructional handbook by blended learning respond the need of the students. It is model to use in teaching and learning. After implementation, an instructional chemistry handbook was able to process the activity and follow the steps. Instruction is easy to use, preparation for teaching and learning are easy to understand, and saves time to explaining, adds more experimental activities in the classroom, time to check, and helping students to do exercises. The learner, able to research themselves, self-responsibility and group, included learning resources from the lessons. Moreover, the students are comfortable and interesting with video, YouTube, PhET, Kahoot, and Google Meet. The students were able to study anywhere anytime, able to observed and experiment follow video or YouTube, and to research information related the lesson. Simpson and Anderson (2009) determined the impact of instruction and blended learning on the level of

knowledge and motivation among ninth-grade German science students. According to the findings, the educational outcomes of the experimental group, particularly their cognitive processes were at a higher level, and improved by teaching integrated learning technique. The study discovered that the teaching and blended learning approach improved student interest, and the findings showed a significant relationship between interest, internal motivation and cognitive learning outcomes. Bailey (2003) investigated how learning tactics affected student-to-student interactions, student-teacher interactions, and student satisfaction and was the goal of this study. The findings did not reveal any variations in the degree of student satisfaction, but they demonstrated that a blended learning technique has positive benefits on raising awareness of student-to-student contact.

2. After the study science process skills of the students, who learned with an instructional chemistry handbook by blended learning, in Unit 1, science process skills were at a moderate level ($\overline{X}$=3.40, SD=0.49). This may be due to science teachers lacking sufficient knowledge and understanding of science content and skills. As a result, teachers were unable to instill science process skills. The students may be disinterested in science and taking science process skills tests in Unit 1. In Unit 2, science process skill is high ($\overline{X}$=3.51, SD=0.50), Unit 3 ($\overline{X}$=3.75, SD=0.54) and Unit 4 ($\overline{X}$=4.10, SD=0.50) were at a high level. Based on the description above, the students develop all science process skills, consistent with the research of Akinbobola, A. O., & Afolabi, F. (2010) and the physics practical tests for the West African Senior Secondary School Certificate in Nigeria over a ten-year period (1998–2007) were examined for science process skills. The results also showed that there were more basic process skills than integrated process skills in Nigerian physics practical exams for the West African Senior Secondary School Certificate, Ketut Budiastra, A. A and Hartinawati, H. (2021) a quasi-experimental method of research was used in this study. The findings demonstrated that students in both the moderate and high categories mastered the concepts and skills of the scientific method. The science content and instructional tools sparked a lot of interest in the students, based on their replies. The internet network needed to enable ICT-based tutorials and the difficulty in breaking the habit of utilizing printed science teaching materials when teaching inside blended learning were the two main challenges.

3. Comparison of achievement on chemistry learning before and after learning with instructional chemistry handbook by blended learning. It was found the result of learning by using instructional chemistry handbook by blended learning. The average posttest score was higher than pretest had a statistically significant difference level of .05. All learning with chemistry instructional handbook by blended learning that created by researcher and have variety of media. The teacher able to presented the content of each topic on internet such as YouTube, Google Classroom, Google Meet, or Telegram. The students are interested and active with learning, ability to seek knowledge themselves, and able to learned anytime anywhere, save time in the classroom to do exercises, able to organize experiment activities, and more practice in the classroom, which was consistent with Carroll, J.B., (1989) and said that teaching methods affected the learning achievement of students. Siribunnam, R., & Tayraukham, S., (2009) discovered that students who learned utilizing

the 7E learning cycle had higher levels of science learning achievement and attitudes about learning chemistry than students who learned using the KWL method.

4. To study the satisfaction of the instructional chemistry handbook by blended learning. Studies have shown that teachers are satisfaction with chemistry instruction handbook. Similar, Gligorović et al., (2014). In a Serbian study of 362 teachers from 57 primary schools revealed that teachers were more satisfied with their jobs. According to Bentea and Anghelache (2012), teachers who improve their success on their professional position through consistent professional development that enables them to be promoted and recognized are more satisfied with their work.

Conclusion

The results of the instructional chemistry handbook by blended learning, which had ten components: (1) instruction; (2) content; (3) objectives; (4) learning processes; (5) media/technology; (6) assessment and evaluation; (7) units; (8) using media and technology; (9) reference; and (10) bibliographies. The learning process of the instructional chemistry handbook chemistry instructional handbook by blended learning, with seven steps: (1) elicit; (2) engage; (3) explore; (4) explain; (5) elaborate; (6) evaluate; and (7) extend. The technology or media of instructional chemistry handbook by blended learning, such as Facebook, YouTube, Google applications, Kahoot app, PowerPoint, and PhET app. The learning assessment was an instructional chemistry instructional handbook by blended learning as formative assessment (pretest, worksheets, science process skills (five skills); and class participation) and a summative assessment (posttest). Blended learning was face to face (50%) and online (50%). The scores of the of the students with the instructional chemistry handbook by blended learning to enhance achievement on chemistry and science process skills for vocational certificate of Polytechnic Institute of Banteay Meanchey Province. In Unit 1, overall, science process skills were moderate and accepted the research hypothesis. In Unit 2, overall, science process skills were high and accepted the research hypothesis. In Unit 3, overall, science process skills were high and accepted the research hypothesis. In Unit 4, overall, science process skills were high and accepted the research hypothesis. the average score of learning to use chemistry instructional handbook by blended learning to enhance achievement on the chemistry and science process skills for a vocational certificate at the Polytechnic Institute of Banteay Meanchey Province were higher on the pretest and had a statistical significance of .05. Overall, the satisfaction of teachers accepted the research hypothesis and interpretation were all high. In light of the findings of this research, the researcher has the following recommendations. Recommendations for the use of an instructional chemistry handbook by blended learning (1) Teachers should be capable of using instructional chemistry handbook by blended learning as a guideline for organizing appropriate activities. (2) Should study information in the instructional chemistry handbook by blended learning to have knowledge and understanding of organizing activities to develop the students. (3) Should follow up on the results of use the instructional chemistry handbook chemistry by blended learning to develop and increase the potential of students. (4) Should encourage all students to participate in activities as much as possible. Recommendations for further research and development of an instructional chemistry handbook by blended learning, as follows: (1) Due to the consequences on science teaching, should be involved in

other courses. The utilization of the instructional chemistry handbook via blended learning in student accomplishment in other educational areas should be the subject of additional research by the researchers. (2) This study serves as a starting point for further studies that demonstrated the effects of using blended learning with other scientific topics or at higher educational levels. (3) Schools must promote the construction of additional spaces for science-related activities including laboratories and virtual classrooms. Finally, schools should incorporate more integrated science process skills into the skill-bridging program level and chemistry practical examinations in order to increase the propensity for creativity, problem-solving, reflective thinking, originality, and invention-essential components for any science and technological developments.

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