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Team-Based Project Design for Environmental Chemistry and Entrepreneurship Learning

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Abstract

The aims of this study are to integrate Environmental Chemistry and Entrepreneurship, and to investigate its effects on students' motivation in learning. The development process adopted ADDIE model. The final products including learning design and learning tools were validated by three experts. The field trial was carried out using a pre-experimental method using one group pretest and posttest design involving 30 students of chemistry education study program Faculty of Teacher Training and Education, Universitas Jambi. The results of data analysis where t count (22.396) > t table (2.045) and probability value (0.000) < 0.05 can be interpreted that H0 is rejected and H1 is accepted. And the results of the N-Gain Score test are 0.816 and the N-Gain percentage is 81.6% which means that the interpretation category has a high effectiveness value. It can be concluded that the implementation of environmental chemistry and entrepreneurship design through team-based model has an effect on students' motivation in learning environmental chemistry.

Keywords: *Design, entrepreneurship, environmental chemistry, integrating, motivation, team-based project.*

INTRODUCTION

The digital era has brought about various changes in the world of work, industry, business and society. The competencies needed today are not only hard skills, but also soft skills. Even some survey results stated that soft skills are more decisive in determining a person's success than their hard skills (Standley, 2010; Menallack, 2018;). Therefore, education policies in various countries implement learning that is oriented towards achieving 21st century skills. The Indonesian government issued a strategic policy on the implementation of team-based project (TBP) or project-based learning (PjBL) model as one of standards of instructional process in higher education (Ministry of Education, Culture, Researh and Technology, 2023). This model is considered to be able to improve students' skills that are required in global era. Various research results showed that PjBL are quite effective in increasing creative thinking (Fadhil, et al., 2020; Deria, et al., 2023), critical thinking (Tafakur et al., 2023; Khaffah et al., 2023; Sudarmin et al., 2019), and communication skills (Muharromah, 2019). Meanwhile, Bell (2010) said that PjBL teaches students many important things to achieve success in the 21st century through the process of discovery, collaboration, project creation and practicing communication skills and problem-solving abilities. The positive impact of PjBL on the ability to think actively and collaborate has also been reported by Zhou (2023). Meanwhile, Evenddy et al., (2023) stated that PjBL is able to increase the ability to solve real problems. Evenddy (2023) further stated that PjBL can bridge the gap

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between theory and practice in the world of education. Another researchers also reported the influence of PjBL on the formation of students' character (Sukmawati, et al., 2022; Nurfuadi, 2023; Sudarmin, et al., 2023). Project learning is also able to foster students' attitudes, interests and motivation (Sudarmin et al, 2023).

The industrial transformation has had a major impact on the way of business. Kumar et al. (2023) said this era has altered the way in which entrepreneurs conceptualize, function, and collaborate. In recent years, many businesses that used to be well-established are closing down, but many new jobs are emerging supported by digital technology and innovation. Thus, in addition to the HOTS, the higher education students also need to be equipped with entrepreneurial spirits and mindsets to achieve success. This can be realized through the integration of entrepreneurial education into the learning process of courses. In this research, an integrated environmental chemistry-Entrepreneurship (EC-E) teaching design will be developed including learning tools to implement.

Research Objectives

As mentioned above, it is important to develop integrated learning of EC-E with applying TBP model in instructional activities. The research questions asked were: "*How to design an integrated -Environmental Chemistry-Entrepreneurshi (EC-E) with applying TBP to improve the students' motivation in learning environmental chemistry*?". In relation to this question, the objectives of this research can be formulated as follows:

1. To produce a learning design and supporting tools of integrated environmental chemistry-entrepreneurial (EC-E) by applying TBP model.
2. To investigate the impact of the integrated learning of the EC-E using TBP on the students' motivation in learning environmental chemisty.

LITERATURE REVIEW

Integrating Environmental Chemisty with Entrepreneurship (EC-E)

Entrepreneurial education is the process of teaching students the skills and knowledge needed in this digital era in order to be success and survive in global competition. It can be offered at all levels of education, from primary school through graduate school. Variations of entrepreneurship education can be offered at all levels of schooling from primary or secondary schools through graduate university programs (Paolucci, E. et al., 2019; Fadhil, et al., 2021). In its implementation in higher education, entrepreneurship education can be included in the learning activities of various courses. Especially courses with materials related to entrepreneurship. One of the courses is the environmental chemistry on the material of waste management, processing, and utilization. By processing waste, various innovative products can be produced in the form of food (Muzaffar et al. 2023), drinks, souvenirs (Nurhayani et al, 2019), handicrafts, bioactive components (Muzaffar et al. 2023), and so on.

Design and Developmental Methods

In the implementation of design and development research, there are many alternative models that can be used, including: ADDIE, ASSURE, Kemp model and so on. Each model has advantages and disadvantages in its application. In this study, the research team chosed the ADDIE model with five steps, which has been applied by and explained in Molenda (2003) and Holden (2015) as described in Figure 1. This model is considered flexible and adaptable in its application, and therefore, the ADDIE model is widely used by many educational designers and training programmers to develop educational and training programs (Spatioti et al, 2022; Szabo, 2022).

The field trial of the developed product applied the pre-experiment method with a one group pretest-posttest design. This design is one of the experimental methods in research (Arikunto, 2016) and is considered the simplest design and widely used in research methodoly. The research design used was not to compare the control with the experimental class, but to compare the pretest with the posttest value to determine the effectiveness of the treatment. The design of research used was: O_1 X O_2, where: O_1 and O_2 are pretest and posttest scores, respectively (Sugiyono, 2020). The instrument for measuring students' motivation was a questionnaire containing 15 questions with a Likert score (1-4). According to Harapan & Sudibjo (2021) there are five indicators of students' learning motivation, i.e., (a) interest and attention, (b) drive to learn, (c) responsibility in doing tasks, (d) responses to the stimulus given, and (e) enjoyment and attraction during learning activities.

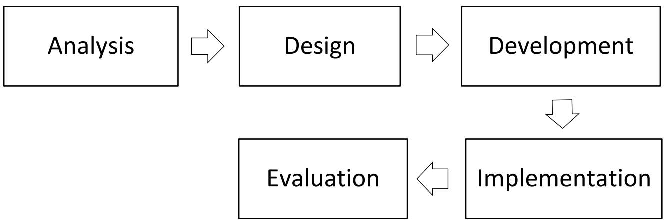

Figure 1. The ADDIE instructional design model

Furthermore, the data analysis of the learning motivation were carried out using *N*-Gain analysis test with descriptive statistical techniques through the assistance of IBM SPSS Statistic 30 software. The prerequisite tests included questionnaire validity, normality and paired t-test.

RESEARCH METHOD

Developing the EC-E learning design and tools

In general, the research activity consists of two parts, namely: (1) Development of the products, including an integrated EC-E learning designs and tools and (2) Trial of the products in a real teaching of environmental chemistry. This development begins with a need assessment, i.e., analysis of educational challenges, student needs, and higher education policies. Based on the analysis results, a draft of EC-E learning design was prepared. The draft was then developed by completing the initial design with teaching and learning activities and learning tools. The products were validated by three experts before being used in a simulation performed by involving 6 students of postgraduate and 3 lecturers of Jambi University. The validator suggestions and comments were used for revising the products. The valid products were tested in a small group with 10 students to get input and assessments from students about the products.

Field trial the learning products

The trial of the products was conducted using quasi-experimental research with applying one group pretest-posttest design in a real teaching of environmental chemistry course followed by 30 students who receive treatment.

$$O_1 \quad X \quad O_2 \qquad (1)$$

where: O_1 and O_2 are scores pretest and posttest, respectively, and X is the implementation of integrated EC-E with TBP design learning.

The implementation of the integrated EC-E design and tools with applying TBP model was assessed by four observers using an observation instrument containing 20 questions with a Guttman scale of 1 and 0

(Guttman, 1944). The implementation of teaching and learning process was calculated using the following formula:

$$\% \, Implementation \, of \, learning = \frac{Total \, score \, obtained}{Maxium \, score} x \, 100\% \qquad (2)$$

Furthermore, Table 1 below was used to determine the category of the implementation.

Table 1. Categories of learning implementation

Scale Range	Category of Implementation
85 – 100	Very good
70 – 84,99	Good
55 – 69,99	Fair
40 – 54,99	Less
< 40	Poor

The instrument for measuring students' learning motivation was a questionnaire containing 20 questions with a Likert score (1-5). Five indicators of students' motivation in learning environmental chemistry used in this study were: (a) interest and attention, (b) drive to learn, (c) responsibility in doing tasks, (d) responses to the stimulus given, and (e) enjoyment and attraction during learning activities (Harapan & Sudibjo, 2021). Furthermore, the data analysis of the learning motivation were carried out using *N*-Gain test with descriptive statistical techniques by using the assistance of IBM SPSS Statistic 30 software. The impact of the implementation of the products was calculated from the percent effectiveness using formula as follows:

$$Student \, Motivation = \frac{Total \, Scores \, obtained \, by \, student}{Total \, score} x \, 100\% \qquad (2)$$

Table 1 below was used to determine the category of the effectiveness of .

Table 2. Categories of learning motivation

Scale Range	Category of Motivation
≥ 80.00	Very high
60.00 – 79.99	High
40.00 – 59.99	Medium
20.00 – 39.99	Low
< 20,00	Very low

In addition to the learning motivation, students' opinions or assessments of the overall learning activities using EC-E design and learning tools were also requested by filling out a questionnaire.

FINDING AND DISCUSSION

Description of learning design of integrated EC-E using TBP

The designing and developing an integrated Environmental Chemistry-Entrepreneurship (EC-E) and learning tools was initiated with an analysis stage. The analysis includes the market and students' needs as weel as the environmental chemistry course materials. The literature study results showed that the industry 4.0 era requires high-level thinking skills that include 5Cs (i.e. complex problem-solving skills, creativity, critical thinking, collaboration, and communication). To achieve these skills, the Ministry of Higher Education has set the TBP model as one of the learning standards in higher education. In addition to the 5Cs, this era also requires an entrepreneurial spirit to face the challenges of disruption. With entrepreneurial spirit, students can develop and implement smart technology, business models and new products by utilizing advances in digitalization, automation, and data analysis that allow a business to adapt and thrive in a rapidly changing market landscape. In this case, AI, IoT, and big data technologies provide fertile ground for the development of innovative products and services, which entrepreneurs can utilize to create disruptive solutions.

The importance of 5Cs and entrepreneurial spirit has been realized by today's students. This can be seen from the students' views illustrated by the results of a survey (Asyhar and Effendi, 2022) involving 75 students of chemistry education Faculty of Education and Teacher Training, Jambi University as respondents. According to the students, creativity, innovation, and entrepreneurial spirit are of the determining factors of success in the real life. They do not consider the GPA to be a dominant factor. The reasons of students is with creativity, innovation and an entrepreneurial spirit, someone can develop a business and be able to compete in the global era. Also, entrepreneurship efforts can make a significant contribution to economic growth by creating new jobs, stimulating innovation, and encouraging competition in the market. This is where it is important to integrate entrepreneurial education into chemistry curriculum and learning activities. This is in accordance with the results of Stanley's survey (2018) which stated that a person's success is more determined by soft skills and attitude factors, while GPA is ranked 21st (Stanley, 2018).

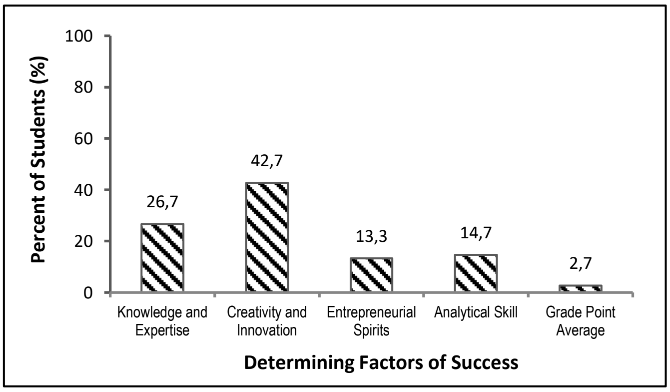

FigURE 2. Students' views on the determining factors of success

The entrepreneurs need to have an entrepreneurial mindset. For this reason, a planned entrepreneurial education needs to be integrated with the higher education curriculum as wellas learning activities in higher education. Entrepreneurial education can change the students' mindset and build the spirit of entrepreneurship. According to Nhleko & Westhuizen (2022), by adapting entrepreneurial education to Industry 4.0, the educational institutions can foster a new generation of entrepreneurs who are equipped to navigate and capitalize on the transformative technologies and opportunities of the digital era.

Table 3. Topics of Environmental Chemistry Course

Lectures	Topics of Materials	T-L Model	Time (min.)
I	Introduction to Environmental Chemistry	Expository	100'
II	Global Issues on Environment	CBL	100'
III	Sources, Fate, and Occurance of Chemicals Released in the Environment	Expository	100'
IV	Atmosphere and Air Pollutio	CBL	100'
V	Waters and Water Pollution	CBL	100'
VI	Soil and Soil Pollution	CBL	100'
VII	Principles of Occupational Health and Safety	Expository	100'
VIII	Exam I (midterm)	Written	100'

Lectures	Topics of Materials	T-L Model	Time (min.)
IX	Environmental Sampling Techniques, Preparation and Analysis	CBL	100’
X	Principles of Green Chemistry	CBL	100’
XI-XV	Food Additives and Addictives/Drugs	PjBL	600’
	Waste Management		
	Waste Processing and Utilization		
XVI	Exams II (Penilaian Hasil Karya Proyek)	Optional	

Analysis of the learing materials as listed Table 3, the Environmental Chemistry Course for the S1 Chemistry Education Study Program Jambi University contains one topic that are very suitable for the characteristics of the TBP project, i.e. Food Additive and Adictives, Waste Management, and Waste Processing and Utilization. These topics were selected to integrate with entrepreneurship materials and developed a design of the entrepreneurial education-environmental chemistry (EC-E) applying TBP model and its learning tools.

Table 3 shows that the integration of entrepreneurial education and environmental chemistry materials is performed by the end of the main activities of the TBP. This is reasonable, because if the entrepreneurship materials is placed by the end of core activities, it will attract more interest from students for the discussion can be directly linked to the project products of their work as entrepreneurial material. Each stage in the design was then completed with description and learning devices.

Table 4. Integrating Entrepreneurial education by the end of main activities of learning process

Teaching and Learning Process		
Opening Activities	Main Activities	Closing Activities
○ **Greeting students** ○ **Inform the learning goals and scope of materials.** ○ **Apperception and motivation.** ○ **Deviding students into groups with 5-6 members.**	**Environmental Chemistry (EC)** with applying TBP/PjBL ○ Explaining the 5-Phases of the teaching model TBP, students’ tasks, etc. ○ Implementing TBP/PjBL with 5-Phases ○ Assessing the effectiveness of integrated learning in EC.	○ Informing the next topic and students’ tasks that should be completed or completed. ○ Closing teaching and learning activities and saying goodby to the students.
⇨	**Entrepreneurship (E)** ○ Delivering EE materials ○ Evaluating the implementation of integrated learning EC-E with TBP.	⇦

From the learning design of EC-E with TBP, it was then developed a set of learning tools, including five lesson plans for five meeting (lecturing), and the instruments for the implementation purposes.

Table 5. Learning design for implementing integrated EC-E by TBP model

Topics of Students’ Projects	1. **Waste Management, Processing and Utilization** 2. **Food additives and Adictives**

Learning Outcomes	After following this lectures, students: 1. are able to identify various problems in environment conserning municiple and domestic wastes 2. are able to demonstrate their concern for society and the environment and have an entrepreneurial spirit and mindset. 3. are able to apply the principles of green chemistry and 4R in real life activities. 4. are able to solve problems in industrial and local community connected to wastes management and processing. 5. are able to design a project to develop products of entrepreneurship. 6. understand food additives and addictives and their negative effects on human health
Approach, Model & Methods	Approach : Scientific Approach Model : TBP/PjBL Methods : Discussion, Q-A, presentation, investigation, observation, library research
Media	Video, photos, real objects, project apparatus and materials
Principles Applied	1. Principles of green chemistry (12 principles) 2. Principles of 4Rs 3. Principles of sustainability (10 principles) 4. Principles of Education for Sustainable Development 5. Principles of healthy living
Time Allocation	600 min. (6 meetings)

LESSON PLAN

Instructional Process	Lecturer (L) Activities	Students' (S) Activities
Opening Activities	○ Greeting students & opening the lectures ○ Giving apperception & motivation ○ Informing the learning goal, scope, model (step 1-5), students' tasks and grouping students ○ Facilitating students with references and basic theories	○ Students pay attention and take notes ○ Studnts ask questions everything that are not yet understood regarding learning and assessment systems. ○ Students form several groups of 5-6 members
Main Activities	**Material 1. Environmental Chemistry (EC):** By using TBP/PjBL model 5 phases:	
	Phase 1. Starting with the essential questions ○ Lecturer began the lesson with showing two videos presenting problems, including in: (1) Food additives (V-1) and (2) Market and domestic wastes (V-2). ○ After showing the two videos, the lecturer encouraged students to provide comments and ask essential questions. L : "Okay, you just watched 2 videos. Now please give your comments and questions related to the contents of the videos. Your questions are very important for the next activities, as a fundation of your projects. Who is the first? Please raise hand if you have question".	S1: "O yea, I would like to comment. Based on my experience and observation, solid waste from traditional and domestic markets has recently become a problem that disrupts the environment and public health. This must be handled immediately so that it does not get bigger and more dangerous". S2: "I have a qustion, Sir. I see that there are lot of fruit and vegetable wastes in the market and domestic wastes. Can that wastes be used as nutritious food/drinks or animal feed and so on? " S3: "And there is also a lot of plastic waste, coconut fiber and shells and others. Can't plastic waste be processed into fuel and wood waste, coconut fiber, and shells be used as raw materials for briquettes?" S4: "In the other video, various cases were seen due to the misuse of food coloring substances. such as the use of textile dyes and even corpse preservatives in food ingredients. This

		is very dangerous for consumer health. Can we make food preservatives and colorings from natural ingredients that have no side effects?" S5: "Also, more importantly for the community, a simple way to identify hazardous substances in food. Maybe we can make it from natural ingredients too?"
	Phase 2. Designing a project and schedule (proposal) ○ Lecturer guided students to prepare planning, design and schedule of projects with mutually agreed topics. ○ Lecturer facilitated students with the basic theories, references and new researches supporting their project plan (proposal). ○ Lecturer explained what and when tasks should be completed by students.	○ Students discussed in group to select the topic of project. ○ Students prepared a proposal or project plan cantaining design, schedule, supporting apparatus dan materials as well as location and duration of the project. ○ Project topics proposed by six student groups, namely: *1. Utilization of pineapple skin waste as a chip material.* *2. Utilization of fruit waste as nutritious silkworm feed.* *3. Making fragrant briquettes from a mixture of coconut waste and used oil as fuel for satay traders.* *4. Making natural dyes for healthy food and beverage products.* *5. Appropriate technology (TTG) for identifying hazardous substances in food and beverages.* *6. Making brownies from dragon fruit skin waste.* ○ Preparing learning tools, materials and surveying project activity locations
	Phase 3. Conducting project and monitoring progress ○ Lecturer monitored the project in location ○ Lecturer assessed and provided notes and suggestions for improving the projects.	○ Students performed project in 2-3 weeks in a location. ○ Students discussed what have been performed and produced ○ Students studied the basic theories and principles and connected with their projects
	Phase 4. Presenting or exposing products & assessment ○ Lecturer assessed the effectiveness of the implementation of the integrated learning EC-E with TBP.	○ Students present and expose their products of the projects. ○ Students make a final report of their projects. ○ Students follow exams and give responses to the learning process.
	Phase 5. Evaluating the implementation of learning ○ Lecturer evaluate the implementation of the instructional design and supporting devices.	○ Students provided assessments and responses to integrated learning of environmental chemistry-entrepreneurship education. ○ Students explained the benefits of the integrated learning EC-E with TBP.
	Material 2. Entrepreneurial Education (E): By integration into EC	
	○ The lecturer delivered entrepreneurship education materiasl (definition, values/spirits) and strategies for building entrepreneurs in the digital era.	○ Students follow the lectures and discuss the topics of entrepreneurial education
Closing Activities	○ Informing students' tasks that should be completed, then closing classroom activities with greeting students.	○ Students make notes and ask the lecturer what they did not understand completely.

The integrated learning design of EC-E and tools were validated by three experts. The valid products of the learning design were tested in a simulation followed with trial I and II. The comments and recommendations from the experts and simulation participants were used for revising the research products to obtain learning design in Table 6.

Table 6. Summary of product revisions during the development and implementation process

Source of Revisions	Criticisms, Comments and Recomendations	
	Learning design	Learning tools
Experts	• Entrepreneurship education should be designed at the end of core learning activities, and noat at the beginning of teaching. • Entrepreneurship materials should be directly linked to the products produced from students' TBP projects. • Learning needs to begin with apperception and motivation as well as an explanation of learning objectives, students' tasks in each lesson plan, so that students understand the benefits of increasing their interest. • The topics of project designed for students should be linked with real problems encountered by local community	• It is better for lecturers to use audiovisual media to introduce problems to students to attract their attention. • The Student Assignment Plan (RTM) is too instructive so that students cannot develop their critical thinking & creative skills. The RTM should be discussed with students • Lecturers need to prepare monitoring schedules and assessment instruments with students.
Simulation Participants	• The time allocation designed for opening learning is too long, it needs to be shortened	• Students need to be directed to prepare a simple proposal for their project and discuss it with the lecturer.
Small Group Trial (Trial I)	• To save time, it is best to divide the groups before the lesson begins, and this can be assigned entirely to the class coordinator.	• Lesson plan should be distributed to students before the lecture for them to study.
Real Teaching Trial (Trial II)	• Duration of videos was too long at the beginning, it took much time in opening stage	• Non essential materials are better delivered by flipping classroom

Table 7. The validity of the developed learning design and supporting devices

Validity	Indicators	Scores of Validators				Categories
		1	2	3	Avarage	
Learning Design	Objectives	4.5	4.4	4.6	4.50	Very valid
	Content Structure	4.4	4.5	4.5	4.46	Very valid
	Delivery Model and Methods	4.4	4.4	4.4	4.40	Very valid
	Evaluation Strategy	4.2	4.2	4.4	4.26	Very valid
Learning Tools	Subject Matter	4.2	4.3	4.4	4.30	Very valid
	Lesson Plan	4.5	4.4	4.3	4.40	Very valid
	Instructional Design Elements	4.2	4.3	4.3	4.26	Very valid
	Assessment Instruments	4.0	4.0	4.0	4.00	Valid

The criticisms, comments and recommendations from the experts team, simulation and trial I used for revising of the products of integrated EC-E design and tools. Field trial (testing II) was conducted through the implementation of EC-E design and learning tools in real learning activities of Environmental Chemistry Course. Based on the learning design and tools validation analysis, the average scores given by the experts for the learning design and tools were 4.35 and 4.55 respectively. This means that the developed learning products have met good validity.

Implementation levels of the learning products

Figure 3 shows that the average values of the implementation levels given by four obserbers were 88, 85, 83, 83 and 85% for learning activities in opening, PjBL Phases, EC and EE Materials, and closing steps,respectively. In general, this values were in the range of very good implemention.

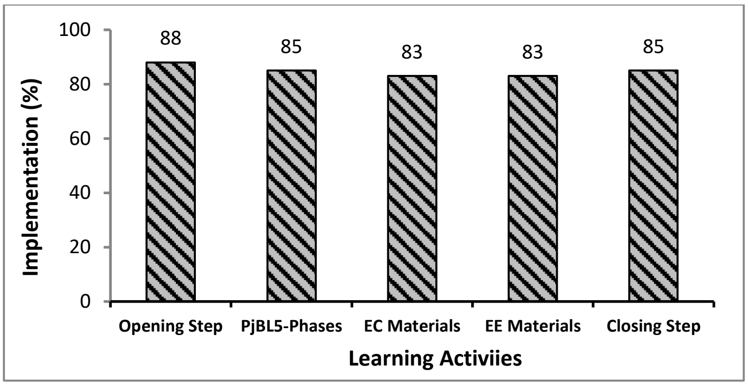

Figure 3. Implementation levels of EC-E design and tools using TBP

The high level of the implementation of EC-E design and devices integrated with the implementation of TBP is due to good cooperation between lecturers and students in managing learning activities and the active involvement of both. In addition, monitoring by lecturers during project activities also makes the learning process run well and smoothly. This is in accordance with what was stated by Sari et al. (2024) that the role of lecturers is quit needed in the implementation of project-based learning.

Impact on students' learning motivation

The quantitative data of pretest and postetst of students' learning motivation assessment were tested for normality as a condition for conducting hypothesis tests, and the results of the tests are depicted in the following Table 8.

Table 8. Pretest-posttest normality test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest Motivation	.147	30	.096	.901	30	.090
Posttest Motivation	.110	30	.200*	.973	30	.616

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Data on normality Kolmogorove-Smirgove test results as depicted in Table 8 show that the significance scores (Sig. data) both in that the pretest (0.096) and posttest (0.200) > α (0.050), so it can be concluded that both data are normally distributed.

The hypothesis test was carried out using the paired t-test data analysis technique. This is a different test analysis technique in conditions before and after treatment on the subjects. To find out whether the hypothesis was proven, it was known that the calculated t-result > t-table, meaning that H0 is accepted and H1 is rejected. To find out the t table value, we looked at the critical table where the degrees of freedom are obtained based on the formula (df) = N-1. The t-test results can be presented in Table 9.

Table 9. Paired sample t-test results

Paired Sample Test								
	Paired Differences							Sig. (2-talid)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	
				Lower	Upper			
Pretest-Posttest Motivation	-25.033	6.122	1.118	-27.319	-22.747	-22.396	29	.000

Table 8 shows that the results of the t-test in both groups have a Sig. (2-tiled) value of 0.000 and a calculated t value of 22.396. So, the calculated t value(22.396)>t table (2.045), whereas the probability value (0.000) < 0.05. This means that H_0 is rejected and H_1 is accepted.

To determine the effectiveness of the implementation of integrated EC-E learning, the N-Gain test was used which was carried out by calculating the difference between the posttest and the pretest scores as follows:

Table 10. The results of N-Gain test

Descriptive Statistic					
	N	Minimum	Maximum	Mean	Std. Deviation
N-Gain_score	30	.49	1.00	.8162	-1955
Valid N (listwise)	30				

Table 10 shows that the results of the N-Gain test with a score of 0.816 > 0.70 means that the interpretation category has a high effectiveness value. Thus, it can be concluded that the implementation of integrated learning EC-E with TBP in environmental chemistry courses has an influence on student learning motivation, which is 81.6%. This can be explained that the TBP learning provides students with the opportunity to be critical and creative in applying their knowledge to solve real problems encountered in the field. Through the project activities, they can build good cooperation and communication with mutual respect, both with fellow team members and the community. This is similar to the results of a study reported by Muharromah (2019) and Zao (2023). The students also considered that the integration of entrepreneurship and environmental chemistry materials was very useful for them because it opened their mindset and provided inspiration in analyzing business potential that could be developed.

Benefits of the learning products for students

To understand the benefits of the learning products for students, a student response questionnaire was distributed to be filled in according to their assessment. The results of the analysis is presented in Table 11.

Table 11. Students' responses to EC-E learning with TBP

Aspects obserbed	Values (%)			
	VS	S	NDS	DS
What do you think about the EC-E integrated learning with the TBP model that you are following? in terms of:				
○ Design of integrated learning	100.0	0.0	0	0
○ Learning tools	94.3	5.7	0	0
○ Implementation of learning activities	100.0	0.0	0	0
○ Time allocation	90.0	10.0	0	0
			Yes	No
Are you interested in following the next project learning at the next meeting?			100	0

Is this kind of integrated learning something new for you?	96.7	3.3

VS = very satisfied, S = satisfied, NDS = neither dissatisfied or satisfief, DS = dissatisfied

Table 11 illustrates the results of the analysis of student responses after attending five lectures of integrated EC-E by implementing TBP model. Almost all students were very happy (89.2%) and happy (10%) working on the projects and only 0.8% stated that they were not very happy. This means that the design of EC-E with TBP can increase students' enthusiasm and motivation to learn environmental chemistry. From Table 11, it was found that almost 100% of students were satisfied with the EC-E integrated learning materials with TBP. Most of them gave the reason that the combination of EC-E materials was beneficial for them related to their needs in this digital era, namely: entrepreneurial spirit. According to Saputa et al. (2023) students are expected not only to focus on finding work after graduating but also to be able to create jobs with the entrepreneurial skills they have acquired on campus. The application of project assignments in EC-E learning also makes them happy to work in the field with the community.

CONCLUSIONS

The design of integrated EC-E learning with the application of the TBP model can be developed through enrichment of environmental chemistry course with entrepreneurship education materials. There are three alternatives of design of the integration, i.e. at the beginning, by the end of main activities, and at the end of the closing stage. And, the integration at the end of the core activities was considered to be the best design due to the combination of the environmental chemistry project products and entrepreneurial education materials strengthen each other in forming the entrepreneurial characters of the students.

The implementation of learning design and devices of the integrated entrepreneurial education and environmental chemistry materials with the TBP model was effective to increase students' motivation in learning environmental chemistry because the activities are very enjoyable, provides many benefits for students, not only related to knowledge about the material but also can foster an entrepreneurial mindset and spirit. The design of the implementation and EC-E learning tools produced from this study are very useful for students because with the TBP model they can apply their knowledge to solve problems in real life. High level of implementation was because the students' project assignments are well planned and involve students in their planning and implementation. Meanwhile, the team of lecturers who act as facilitators also actively monitor each stage of the learning activities.

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