



The Development of Innovation and Chemical Entrepreneurship Module for Pre-University Students: An Analysis Phase of ADDIE Model

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ABSTRACT

The present study is the initial stage; an analysis phase, which aimed to identify suitability and the need of the module development for pre-university students. The module will be developed based on two main elements: Innovation and Chemical Entrepreneurship (CEP). Using ADDIE instructional model, through analysis phase, the suitability, and the need for the module development, are identified through three collected data: (a) module of suitability in semi-structured interview, (b) student need analysis questionnaire, and (c) module of need analysis questionnaire. Five experts in STEM, Chemistry, innovation, and entrepreneurship area are interviewed to collect data (a) and will give the suitability and arrangement of the module content. Whereas the data survey (b) is collected from 60 pre-university students through random sampling from a college in Penang, Malaysia, and data survey for (c) is collected from all 40 Chemistry Lecturers. The qualitative interview is necessary to confirm the suitability of the main elements; innovation and Chemical Entrepreneurship in the module, while the quantitative data from two surveys; (b) and (c) give confirmation on components and requirements for the development of the modules from the students and the lecturers perspective. Data analysis for (a) was performed by using ATLAS.ti Version 22, whereas data analysis for (b) and (c) was performed through descriptive statistics. The qualitative data obtained from (a) confirmed the suitability of innovation and Chemical Entrepreneurship elements to be integrated into the learning module for pre-university, and the quantitative data from (b) and (c) successfully listed main components to be included in the module, such as learning outcomes, enhancement activities and reflections. The findings indicated that it is suitable and there is a need to develop i-CEP Module for pre-university students

Keywords: *analysis phase, innovation, chemical entrepreneurship, learning module, STEM approach.*

INTRODUCTION

Chemistry in STEM (Science, Technology, Engineering, and Mathematics) education encompasses all three components of STEM education: as a STEM field, (ii) as a STEM subject, and (iii) as a STEM approach. It lays emphasis on chemical production in industry and for consumers, as well as users of chemical technology in the manufacturing, food, health, energy, and environmental sectors (Firman, 2019; Ministry of Education Malaysia, 2016). In the context of post-secondary or pre-university education, the purpose is to develop students' talents and personalities, producing critical thinkers, creative, innovative, responsive, skilled, and competitive in meeting the needs and requirements of their careers. (Yulastri et al., 2017). The goal of this pre-university programme is to raise the educational standard to a higher level, to provide education based on the term system, and to produce students who are competitive and have a

high marketability value through three main skills: cognitive skills, manipulative skills, and soft skills (Ministry of Education Malaysia, 2015).

As a result, these students should be more competent and capable of contributing to the country's educational and economic development standards. They should not be overlooked in the context of STEM, especially since they have been equipped with the fundamentals of science stream learning at the secondary level. STEM entails the integration of more than one Science discipline, as well as application to the concept of pure science and social science principles (Norhaqikah Mohamad Khalil & Kamisah Osman, 2017). As a consequence, Chemistry, as one of the STEM courses, should not only focus on remembering theories and concepts, but should also be used in real life, where students can conduct concrete discussions and research on a phenomena or product (Firman, 2016, 2019; Situmorang et al., 2018). Chemistry mastery should also be capable of producing highly trained pupils for the needs of the country in the twenty-first century. To ensure the sustainability of Chemistry Education, the implementation of teaching and learning Chemistry must be tailored to the demands and requirements of today's society (Redhana, 2019).

Innovation project is one way of learning experience that can deliver "real-world" learning while also provides high levels of cognitive, manipulative, and soft skills (Fisk, 2017; García-Manilla et al., 2019; Hero & Lindfors, 2019). However, the production of an innovation is pointless if it has no commercial value (Ishak et al., 2014). Chemical innovation should be able to assist students in translating chemical knowledge into practise and discovering new information by stressing the material's applicability in terms of commercialization (Situmorang et al., 2018). Thus, good innovation demands good entrepreneurial knowledge and skills so that the products, materials or methods produced become something meaningful (Noor Natasha Nadia, 2011). The concern that emerges is, earlier research has generally isolated the factors of innovation and entrepreneurship. Because product commercialization within entrepreneurial skills is complementary to quality innovation, the elements of innovation and entrepreneurship should not be separated and should be combined according to the appropriateness of teaching and learning practises (Ghatora & Strutt, 2017; Mark et al., 2018; Sapounidis et al., 2016; Spillan et al., 2019; Zokowski et al., 2016). To that end, the purpose of this study is to develop a pre-university learning module that integrates elements of innovation and entrepreneurship. Because this study focuses on Chemical Education, the elements used for entrepreneurship with a primary emphasis on Chemistry are interpreted to as Chemical Entrepreneurship (CEP).

This module will be developed using the ADDIE Model proposed by Branch, (2010). The ADDIE model is also often the choice as it is a pioneer in module development as well as an development to other instructional models (Branch, 2010a; Daud, 2017; Forest, 2017; Kurniati et al., 2017). The ADDIE concept is well suited to complex learning environments as it provides a systematic module development guide and has an assessment process for each phase (Hess & Greer, 2016). This makes it unique compared to other models because module developers have the opportunity to undergo a process of continuous module improvement (Othman, 2013). In addition, ADDIE was chosen because it has been a reference by many previous researchers in developing effective module designs (Ummu Nasibah Nasohah et al., 2015), easy to learn, as well as systematic in the process of structuring learning materials according to the specifications of learning needs and objectives (Yulastri et al., 2017). This study will critically discuss the analysis phase in developing the module.

An analysis phase is critical for determining whether this study is required. It is a systematic and thorough method of identifying a need and achieving the intended goal (Bash, 2015; Carin et al., 2017; Forest, 2017; Hashim et al., 2017; Mastuang et al., 2019). This phase's goal is to guarantee that the learning modules created are adequate and meet the needs of students as well as content requirements. This phase's findings also identify the methods that will be involved in generating instructional materials, strategies, and activities, i.e. the module, as well as assessing

the acceptability of the created instructional based on the needs of students (Husaini Kasran et al., 2015).

METHODOLOGY

This development research used the ADDIE Model; hence, we adopted and adapted all five ADDIE phases: analysis, design, development, implementation, and evaluation. Because the current paper focuses solely on the analysis phase, we will only describe the methodology and findings acquired during this phase. Since it is the first phase in the ADDIE Model, it serves as the foundation for setting goals and activities for succeeding phases (Branch, 2010a). In this phase, suitability and need analyses were carried out to answer two research questions: (1) Is it suitable to use elements of innovation and Chemical Entrepreneurship for science stream pre-university students? and (2) What are the components required in the development of the innovation and Chemical Entrepreneurship module (i-CEP Module)? The analysis phase is responsible for compiling the core framework and delivery mechanism of the concepts or materials to be used in the (Aldoobie, 2015; Branch, 2010b; Yulastri et al., 2017). Thus, in the context of this study, in analysis phase, we focused not only on need analysis, but also on suitability analysis to develop a learning module.

There are three types of samples used: (i) five experts for suitability analysis, (ii) 40 Chemistry pre-university lecturers for need analysis, and (iii) 60 science stream pre-university students for need analysis. The five expert is purposely selected based on their requirement; have more than 10 years' experience in teaching Chemistry at pre-university level, or any STEM field, and involve in STEM innovation or have more than 10 years' experience in entrepreneurship. Out of 40 Chemistry pre-university lecturers, 35 of them were female, while the remaining five were male. As for the 60 sample of students, 42 of them were female, while the remaining 18 were male. The experts, lecturers, and students (samples) chosen are based on their criteria, thus the sampling used is purposive sampling technique. Details explanation on these sample is discussed later in this paper.

In collecting the data, we used three types of instruments: (1) Module Development Suitability Analysis Interview Question, (2) Student Needs Analysis Questionnaire, and (3) Student Needs Analysis Questionnaire. The first instrument, a semi-structured interview questions with 15 items, were conducted to address the first research question, which is based on suitability analysis and involves qualitative data. Whereas the second and third instruments; both consist of 17 items and one open-ended (qualitative) question are used to answer the second research question. Both questionnaires collected quantitative data on the requirements of the primary components that must be present in the module's development. Data on these component's requirements were collected from two sorts of samples (lecturers and students), using two types of questionnaire instruments mentioned before. Although the questions in both instruments are the same, the language structure of the questionnaire items in both instruments is tailored to the context of students and lecturers. However, the anticipated results from both instruments are the same: determining the requirements of the module's primary components. Statistical Package for the Social Sciences Software (SPSS) version 26.0 was used to examine quantitative data from these two instruments in a descriptive manner for the basic analysis, such as determination of percentages, and frequencies of data from both questionnaires. In this study, the questionnaires were completed online in the form of a Google form. Questionnaires were chosen because this method of data gathering necessitates a quick response time, making it easy for respondents to react. The next sections discussed all the instruments used and the data collected.

Module Development Suitability Analysis Interview Question

Module Development Suitability Analysis Interview Question is a semi-structured instrument. It seeks to address research concerns about the suitability of module development by soliciting opinions and suggestions from five experts chosen for their expertise in pre-university Chemistry, STEM, innovation, and entrepreneurship. These face-to-face interviews can provide information on whether the development of modules incorporating elements of innovation and Chemical Entrepreneurship (CEP) is suitable for the level of pre-university students and relevant in improving HOTS, scientific creativity, and learning motivation of pre-university students in Chemistry Education.

There are 15 questions in all, which are divided into seven sections. Section 1 gathers expert information, Section 2 gathers information on STEM concepts in Chemistry learning at the pre-university level, Section 3 gathers information on module development, Section 4 gathers information on innovation and HOTS elements, Section 5 gathers information on innovation and scientific creativity elements, Section 6 gathers information on innovation and learning motivation, and Section 7 gathers information on the combination of elements of innovation and elements of CEP. Some of the 15 items from section 2 until section 7, (section 1 is demographic items) are shared in Table 1. below.

Table 1. Example of semi- structured questions interview

Section	Example of semi structured questions
2	<p>Question 1: STEM is an acronym for Science, Technology, Engineering, and Mathematics. STEM in the context of education in Malaysia encompasses three main aspects; namely STEM as an area of learning, STEM subject packages and STEM as a teaching and learning approach. What is Datuk / Datin / Professor / Associate Professor / Dr. / Mr. / Mrs. / Mr. / Ms. understand about STEM integration?</p>
3	<p>Question 4: Are there any guidelines or modules provided by the Ministry of Education for the purpose of implementing the integration of STEM Chemistry at the pre-university level?</p> <ol style="list-style-type: none"> If yes, name the module or guide that Datuk / Datin / Professor / Associate Professor / Dr. / Mr. / Mrs. / Mr. / Ms. have seen or used. If no, is it appropriate to provide modules or guidelines for the implementation of teaching and learning activities that integrate STEM approach with Chemistry at the pre-university level?
4	<p>Question 6: Higher Order Thinking Skills (HOTS) refers to the ability of students to use high level thinking in Bloom's Taxonomy, namely the skills of analysing, synthesizing, applying, and creating (inventing). In the opinion of Datuk / Datin / Professor / Associate Professor / Dr. / Mr. / Mrs. / Mr. / Ms., is it necessary to apply these skills among pre-university science students?</p>
5	<p>Question 10: Scientific creativity refers to the creativity of students systematically and according to scientific methods such as collecting and recording data, conducting investigations, mastering problem-solving skills, making hypotheses, planning tests and innovations (Zahrman & rasul, 2017). Based on the experience of Datuk / Datin / Professor / Associate Professor / Dr. / Mr. / Mrs. / Mr. / Ms., do pre-university students exhibit scientific creativity in the existing teaching and learning Chemistry?</p> <ol style="list-style-type: none"> If yes, what is the common method used in unearthing students' scientific creativity? If not, what is the method that Datuk / Datin / Professor / Associate

Section	Example of semi structured questions
	Professor / Dr. / Mr. / Mrs. / Mr. / Ms. feel can be used in unearthing students' scientific creativity?
6	Question 13: In the opinion of Datuk / Datin / Professor / Associate Professor / Dr. / Mr. / Mrs. / Mr. / Ms., is the motivation of pre-university students to learn about STEM Chemistry integration related to students' mastery of existing Chemistry subjects?
7	Question 15: A Good innovation requires good entrepreneurial knowledge and skills so that products, materials nor does the resulting method become something meaningful (Noor Natasha Nadia, 2011). In the view of Datuk / Datin / Professor / Associate Professor / Dr. / Mr. / Mrs. / Mr. / Ms., is there a need for knowledge on commercialization in producing innovation? a) If yes, is there a need for a special guide or module that explains how to integrate STEM Chemistry innovation and entrepreneurship approach? b) If no, why?

The questions in this instrument were developed based on problem statement in research study, literature review, and scholarly discussions with three pre-university Chemistry Subject Matter Expert (SME) lecturers with more than ten years of experience teaching pre-university Chemistry.

The analysis phase began with expert interview sessions, with the goal of determining the compatibility of module development with essential factors such as innovation and CEP. This suitability analysis study includes a face-to-face interview with five experts using verified semi-structured interview questions. These face-to-face interviews are conducted in accordance with the schedules and locations agreed upon with the experts. An ATLAS.ti software version 22 is used to analyse these qualitative data. According to the experts' desires and approval, interview sessions were held at their individual workplaces. All these experts meet a few pre-determined criteria, including knowledge in STEM, more than ten years of experience teaching students at the pre-university level in Chemistry or entrepreneurship disciplines, or being actively involved in the production and evaluating of innovations.

Expert 1 is a senior university lecturer who holds a doctorate in STEM and mechanical engineering. He has over 15 years of mechanical engineering experience and is involved in the creation of STEM modules for various secondary schools, notably the engineering division. He is also involved in the production of innovations and has served as a jury for state and national level innovation competitions conducted by the State Education Department (JPN) and Ministry of Education Malaysia (MOE) for over ten years. On a global scale, he serves as a jury member under the aegis of industry and the private sector. He is also a frequent guest at STEM workshops and a go-to expert for building STEM modules for postgraduate students. Expert 2 is a Chemistry Excellence Lecturer from a pre-university institution with over 20 years of expertise in the subject. She actively participates in the development of teaching and learning Chemical innovations and has received gold, silver, and bronze prizes at the collegiate, national, and international levels. She also coaches secondary and primary school innovation teams on behalf of the state, and he serves on the MOE's national STEM innovation jury. She also is a doctorate and serves as the department's research and development (R&D) coordinator. She actively involved in organising the Green Technology Club, a chemistry-focused organisation, at the pre-university and secondary school levels.

Expert 3 is a senior university lecturer in STEM and Chemical engineering with over 12 years of experience teaching pre-university students. He is a Doctor of Chemical Engineering graduate who is actively generating innovations to promote Malaysia internationally and has won

multiple gold and silver medals. He has also moved into the arena of marketing of new items by forming partnerships with industry both within and beyond the country. Expert 3 also teaches entrepreneurship at the university where he works in the Chemical Engineering course. Expert 4 is a senior lecturer in Chemistry with a master's degree from one of the pre-university schools and has more than 20 years of teaching experience. He actively creates his own innovations and cooperates with students to win numerous gold, silver, and bronze medals at the college, national, and international levels. He is also directly involved in the marketing of inventions through cooperation with a public institution for previously developed products. He is still constantly innovating to generate revenue for student development and the institutions he serves through relationships with pre-university schools.

Expert 5 is a senior lecturer at the pre-university level who has been teaching Chemistry for over 20 years. She actively conducts workshops and seminars focusing on product marketability or innovation. She is also one of her department's R&D coordinators. She has also worked as a commercialization jury member for college-level innovation competitions and attended various talk invitations from outside parties and schools.

Module Needs Analysis Questionnaire

This Module Needs Analysis Questionnaire was adapted from Aldoobie (2015) and is given to 40 Chemistry lecturers at the pre-university level chosen. It is done after the instrument being validated and refined. This questionnaire is divided into four sections: (1) Section A collects demographic information about lecturers, (2) Section B contains seven questions about the need for elements of innovation, entrepreneurship, HOTS, scientific creativity, learning motivation, and module development or special guidance for lecturers, (3) Section C collects information on the module's primary content needs, in which the researcher identifies ten components that must be included in the module and the lecturer marks "Yes" or "No" to the components that are thought necessary, and (4) Section D, the final section, includes qualitative data in which the lecturers can provide suggestions for completing out the module, and this data is open response and not compulsory. The questionnaire items are analysed in finding section in this paper. The quantitative results of this questionnaire are critical in determining the need for module development. This questionnaire is formatted as a google form to assist and speed up data collection.

Student Needs Analysis Questionnaire

The items in the Student Needs Analysis Questionnaire are the same as those in the Module Needs Analysis Questionnaire, but they are processed based on sentence structure and language because it is aimed at students. This questionnaire was completed by 60 students from a sample that was representative of a pre-university institution. The questionnaire, like the one given to lecturers, is divided into four sections: Section A collects student demographic data, Section B contains seven questions that collect data on the needs of elements of innovation, entrepreneurship, HOTS, scientific creativity, learning motivation, and module development or special guide to students, and Section C collects data on the main content requirements of the module, where there are ten constructs that must be in the module. Finally, for Section D, the final section, comprises qualitative data, in which students can contribute suggestions for completing out the module, and this data is open response and not mandatory. The questionnaire items are analysed in finding section in this paper. This questionnaire is formatted as a google form to assist and speed up data collection. The quantitative results of this questionnaire are critical in determining the needs of students for module development.

RESULT AND DISCUSSION

This section will report the findings of the suitability analysis and needs analysis studies that have been implemented, according to the instruments used.

RESULT

Module Development Suitability Analysis Interview

The interview questions were designed to answer study question 1 (a): Are the elements of innovation and Chemical Entrepreneurship suitable for pre-university students in the Science stream? The provided questions lead to an evaluation of the suitability of the elements of innovation and CEP to be applied to pre-university students to address the study's questions. The questions were also tailored to the topic of study, Chemistry Education, which employs a STEM approach, as well as the research variables, HOTS, scientific creativity, and student learning motivation in Chemistry Education.

Based on the qualitative analysis performed using ATLAS.ti software version 22, five themes emerged from the development suitability analysis of this module, namely: (1) Suitability of STEM approach in pre-university Chemistry Education, (2) Suitability of innovation element to enhance students' HOTS, (3) Suitability of innovation element to enhance students' scientific creativity, and (4) Suitability of innovation element to enhance students' learning motivation. The next section describes the interview results for the five aspects of suitability.

Theme 1: Suitability of STEM Approaches in Pre -University Chemistry Education

Three codes resulted from the qualitative analysis of the interviews under the theme of Suitability of STEM Approaches in Pre-University Chemistry Education, namely (1) STEM integration, (3) STEM modules, and (3) time. As shown in Figure 1.1, the themes and code that appear are summarised using a code map generated by ATLAS.ti software version 22.

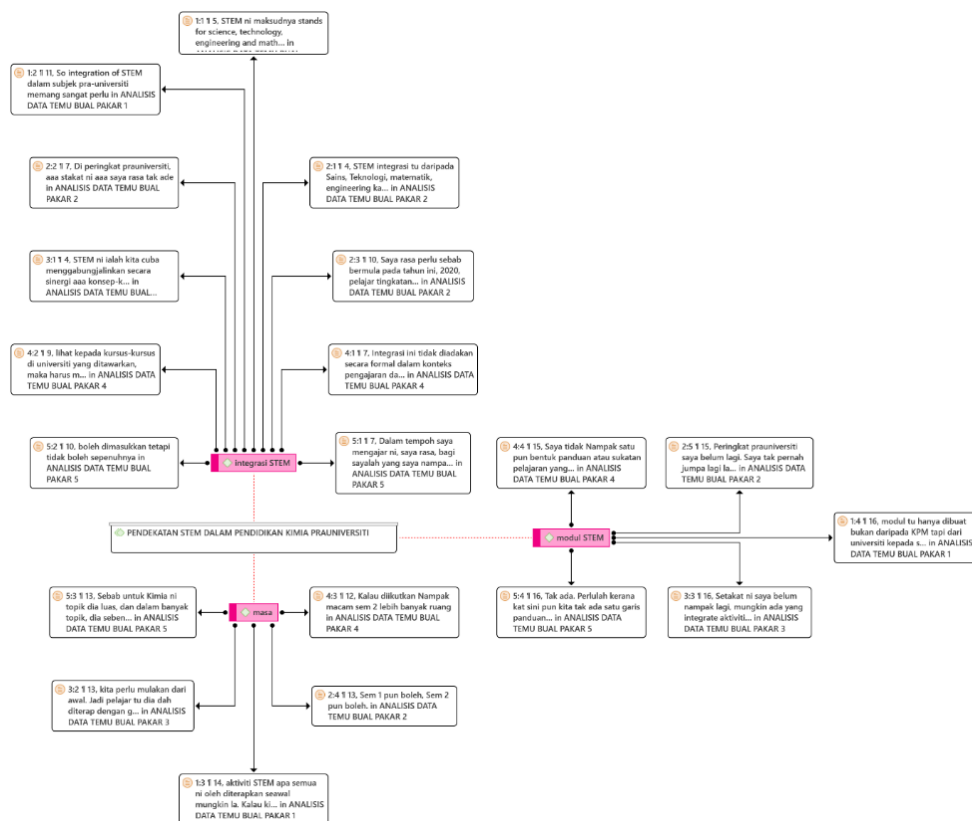


Figure 1. Suitability of STEM approaches in pre-university Chemistry Education code mapping

According to the findings, the STEM term is defined by the five experts as the combination of the disciplines of Science or Chemistry in the context of research, Technology, Engineering, and Mathematics. Because all these experts have taught STEM and Chemistry, they all respond in the same way when being asked about STEM concept. All these experts think that Chemistry Education is well suited to be infused with a STEM approach so that students are better equipped to enter universities where programmes of study are given in the form of STEM disciplines rather than distinct ones. For example, Expert 3 says: *"Honestly, I find that essentially, students still consider the subject individually." For example, students still believe that chemical engineering is chemistry, even though, according to the curriculum, only 5% of chemical engineering is chemistry, and the rest is a combination of physics, mathematics, and so on. As a result, it appears that students at the pre-university level are still enamoured with the concept of studying in school. They face cultural shock when they attend university. They still consider mathematical physics and chemistry to be different subjects."*

This needs to be corrected in students' comprehension so that they understand that Chemistry is a part of STEM rather than a separate subject. As a result, using the STEM approach to these pre-university students is suitable and relevant since those who will enter the university and choose the STEM field before pursuing a profession. According to Experts 2, 4, and 5, there is no official document or official module at the pre-university level that may provide direction on the practise of STEM approaches in teaching and learning, including Chemistry Education. Experts 1 and 2 also agreed that there is no official document from the MOE on the implementation of STEM at the pre-university level, but they stated that there are secondary schools that have taken the initiative to cooperate with public universities in providing STEM activity modules for their respective schools. However, the extent to which it fits the requirements and determines the level of students, and the topic curriculum cannot be determined. This is because these two experts are actively involved in the STEM module's material development. As a

result of this analysis, it is critical and appropriate to develop a learning module that incorporates a STEM approach into Chemistry Education, particularly for pre-university students.

In terms of suitability of time to apply, Experts 1 and 3 believe that the optimal period to introduce students to modules that use this STEM approach should be early in their studies, i.e., in semester 1. The others believe that the implementation time relies on the needs and appropriateness supplied to students during semester 1 and semester 2. As a result of this research findings, a suitable module has been designed to be applied at the start of pre-university studies, in semester 1.

Theme 2: Suitability of Innovation Elements to Improve Student's HOTS

Two codes have formed under this theme: (1) HOTS mastery and (2) HOTS activities. Figure 1.2 shows a code mapping developed using ATLAS.ti software version 22 that summarises the topics and codes appeared.

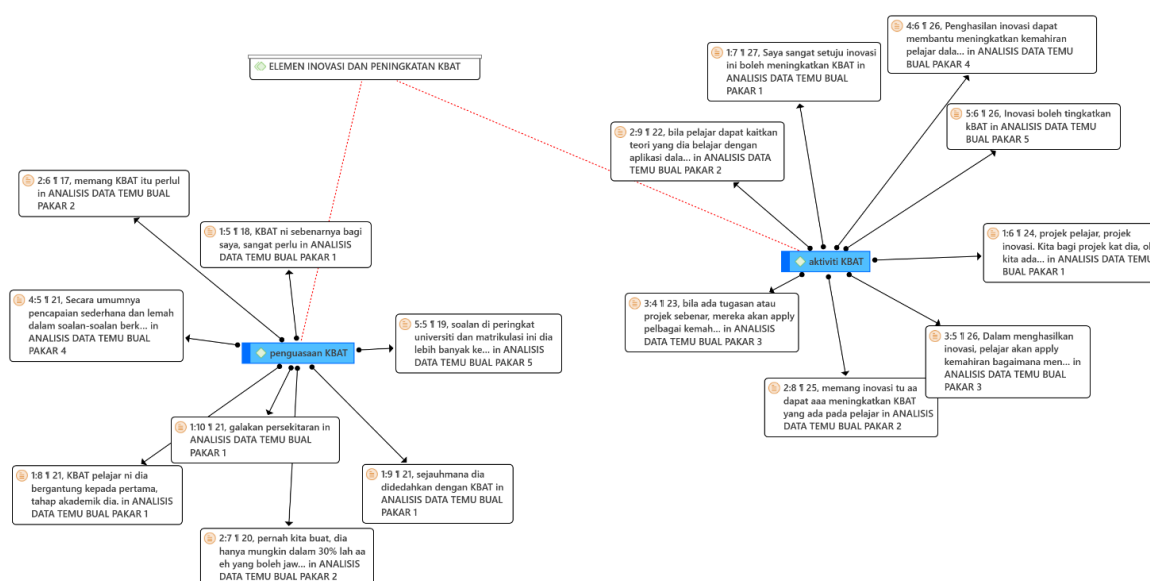


Figure 2. Suitability of innovation element to improve student's HOTS code mapping

From the code mapping, when mentioning about HOTS, the five experts are of the view that the mastery of HOTS among pre-university students is still not encouraging and needs to be strengthened in pre-university level learning. According to Expert 5, the HOTS questions formulated at the pre-university level themselves only involve the level of analytical skills and none involve the skills of applying and creating. Expert 2 and Expert 4 have also given the impression that the achievement of pre-university students is at moderate and poor levels, or only 30% can answer the HOTS' questions given throughout their teaching experience and duration.

Expert 1 stressed that the mastery of HOTS is highly dependent on the academic level, exposure to questions in the form of HOTS, and the environmental encouragement given to students. He is of the view that excellent students basically do not show problems when given questions in the form of HOTS, but for moderate and weak students, HOTS questions or assignments given are a major challenge to students, thus causing students' interest in the subject to decrease. This in turn leads to low achievement situations and even worse leads to dropouts as well as change of course of study.

The second code found in this interview is an activity that has been practiced and can be practiced in helping to improve students' HOTS. Based on the views of Expert 1, Expert 2, and Expert 3, many teaching and learning techniques or strategies have been implemented involving formal or informal HOTS activities at the pre-university level, whether realized by lecturers or

not. However, not comprehensively, i.e., not involving the skills of applying and they invent. During the interview sessions of the five experts, it can be said that there is very little exposure to learning activities that can hone students' HOTS at this pre-university level. Thus, the findings of this interview conclude that the mastery of HOTS is very important and very suitable to create a learning material that can improve the HOTS of pre-university students.

To improve students' HOTS, hands-on activities, project assignments, and experiments have been the recommendations of all five of these experts. They also give the same view that students' HOTS can be improved by providing exposure to real-world learning, for example, giving assignments or innovation projects. Quoting the words of Expert 1: "I strongly agree that this innovation can improve HOTS because the elements in the innovation are quite different from ordinary subjects. Because in innovation, what do we have? We are in about 6 steps in innovation. 5 steps la.. one is an introduction to the problem, so to identify the problem, he has to use scientific tools, to measure the problem. Then he knows what his problem is, he must propose the most logical solution for him. Why do I say logic here? Because what? If we think that it is too high, maybe the tool is no longer there, the cost and so on. So, then the result is how to solve the problem. So, the process is all there, with HOTS". The agreement of the five experts on the ability of the innovation element to improve the HOTS led this study to set innovation as a key element in the study module.

Theme 3: The Suitability of Innovation Elements to Enhance Students' Scientific Creativity

From the qualitative analysis of the interviews, two codes emerged under the theme of Suitability of Innovation Elements to Enhance Students' Scientific Creativity, namely, (1) mastery of scientific creativity, and (2) enhancement of scientific creativity. The emerging themes and codes are summarized using the schematic diagram in Figure 1.3 below.

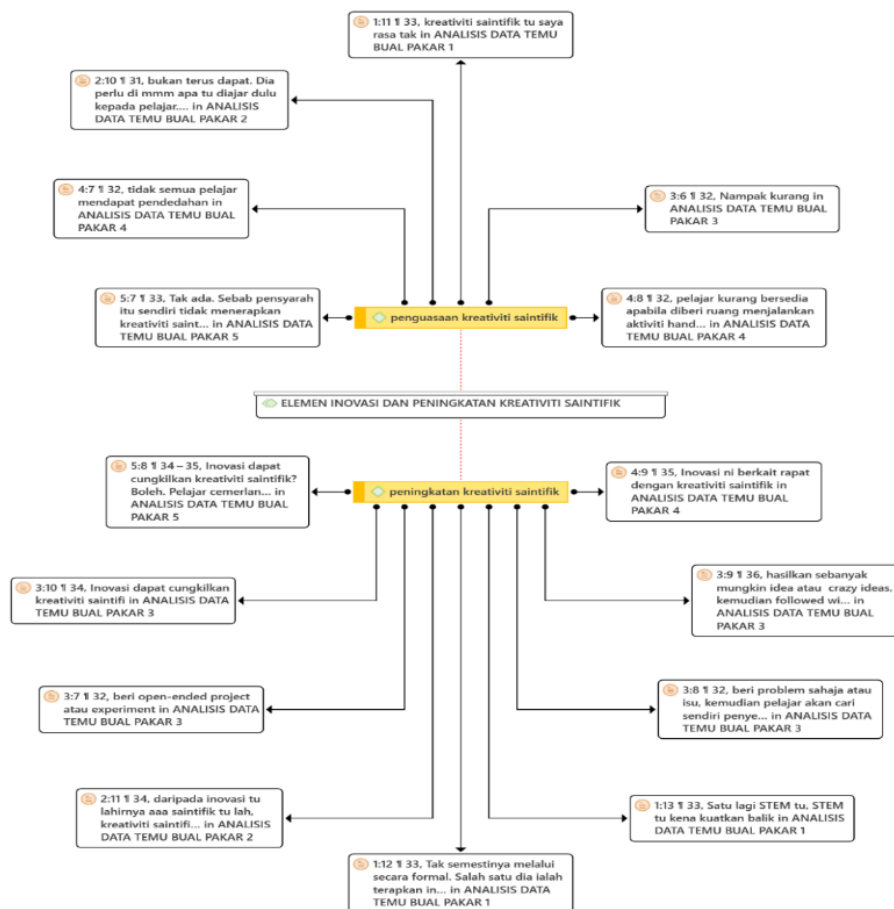


Figure 3. Suitability of innovation element to improve student's scientific creativity code mapping

Touching on the question of students' scientific creativity, it basically starts with a discussion of the mastery of scientific creativity among these pre-university students. All five experts admitted that indeed pre-university students who had been taught did not have these scientific creativity skills. Expert 2 also said not all the students were able to show their scientific creativity while in lesson. Quoting the words of Expert 5, "None. Because the lecturers themselves do not apply scientific creativity. Just keep teaching concepts", he said that the lecturers themselves did not expose students to learning that could unearth students' scientific creativity. These findings indicate that according to experts, there is still a lack of learning exposure that can unearth and hone students' scientific creativity. Therefore, it is necessary to provide a learning material that can provide exposure to the formation and consolidation of scientific creativity skills among pre-university students.

The second code refers to activities that can unearth and enhance students' scientific creativity skills. According to Expert 1, this scientific creativity can be enhanced not only through formal learning but can also be applied through informally. For example, give an assignment or question in the form of an open response, or a brief project. This was also suggested by Expert 2, Expert 3, Expert 4, and Expert 5. They agreed that tasks such as innovation by students, not only can unearth their scientific creativity, but the process of completing the task also helps in enhancing students' scientific creativity. Based on the words of Expert 3: "We teach them, produce as many ideas or crazy ideas as possible, then followed by how to prove the idea is effective they have to look for evidence or scientific data that supports their innovation ideas". Thus, in the learning activities and complement of innovation projects, will help in educating students to generate creative ideas scientifically and focusing on the emergence of prototypes or innovation products that are solutions to the issues given in the innovation assignment. This clearly indicate that elements of innovation can be included in the study module.

Theme 4: Suitability of Innovation Elements to Enhance Student Learning Motivation

Under this theme, three codes have emerged namely, (1) learning motivation, (2) activities increase learning motivation, and (3) the effect of learning motivation. The themes and code that appear are summarized using a code map generated by ATLAS.ti software version 22 as in Figure 4.

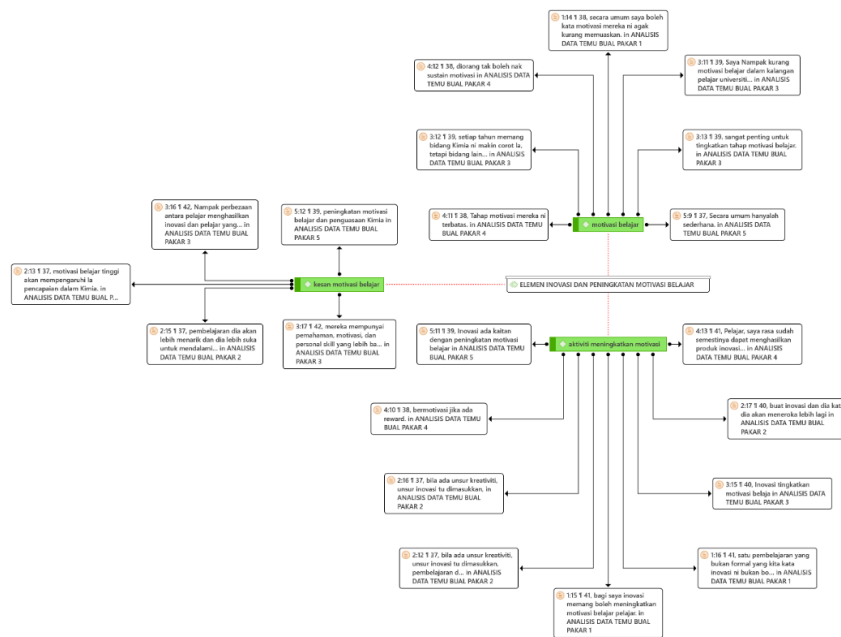


Figure 4. Suitability of innovation element to improve student's learning motivation code mapping

Commenting on the level of learning motivation of pre-university students towards Chemistry Education, all five experts gave the same response that is, the level of learning motivation is at a moderate level, unsatisfactory and limited. Expert 5 also said that the learning motivation of his students was also seen to be unsustainable when given an injection of a motivation improvement program. This was also mentioned by Expert 3, who said that the level of study motivation of his students was unsatisfactory and the university where he worked showed a declining pattern in the number of students taking Chemistry and STEM each year. Quoting the words of Expert 3: *"They do not see an advantage in terms of rewards for studying Chemistry. So, every year, the field of Chemistry is declining, but other fields are dominating such as chefs and culinary. So, it is very important to increase the level of motivation to learn"*.

Therefore, it is emphasized here how important it is to consider the motivation of students to learn because this decline has disrupted the determination of the ratio of science to literature in the country. In discussing this learning motivation, the interview sessions obtained some expert views on activities that can stimulate or enhance the learning motivation of these pre-university students. All five experts think that activities such as innovation tasks can provide a more interesting learning experience and can provide a motivating factor in completing the innovation task. Expert 4 also thinks that if students are rewarded in each task, it will give them more motivation to go deeper and learn a subject concept. Quoting Expert 4: *"With the opportunity of time, opportunity and also cost if there are enough of these elements supplied to students, I think it is necessary to produce innovative products and this will indirectly increase their interest in a subject such as the subject of Chemistry"*.

As shown on the code map, all these experts stated that these innovation projects or assignments could increase students' learning motivation. The third code detected in this interview involved the effect of increasing student learning motivation. Expert 1, Expert 2 and Expert 4 are of the view that the increase in learning motivation has an impact on student achievement in the subject, namely Chemistry. Expert 3 also explained from his experience, there is a significant difference in terms of motivation to learn between students who are heavily involved with innovation projects or competitions compared to the other way around. They are also seen to be more charismatic and skilled when given assignments in the form of projects and applications of teaching and learning concepts. Therefore, based on the findings that have been reviewed, this study has decided to include elements of innovation in the module.

Theme 5: Suitability of Combined Elements of Innovation and CEP for Module Development

From the qualitative analysis of the interviews, two codes emerge below, namely, (1) a combination of innovation and CEP, and (2) a combination of elements guide. The emerging themes and codes are summarized using the schematic diagrams in Figure 1.5

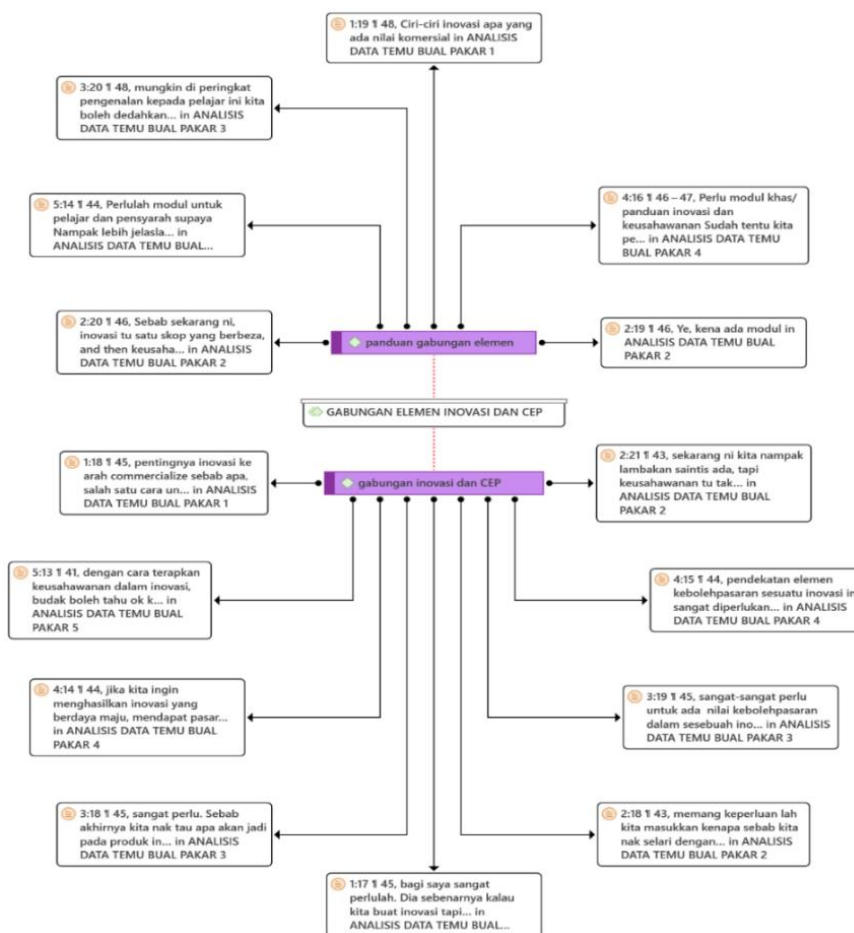


Figure 5. Suitability of combined innovation element and entrepreneurship element code mapping

Based on the code mapping, the five experts agreed to combine the innovation element and the marketability component of the invention, or, in the context of this study, to include the CEP element. Expert 2 also emphasised the gap in developing a generation of science students who later became scientists but were not equipped with entrepreneurial expertise throughout their education. Expert 1 also mentioned that producing innovation without considering marketability or commercialisation renders the innovation less relevant.

Expert 3 stated, "In my opinion, that is highly necessary." Because, at the end of the day, we want to know what will happen to our inventive products, don't we? So we want to know who the target consumer is, how much it will cost, what channel or marketing will be used, and so on. As a result, students may realise that their discoveries can go a long way. In an indirect way, he will catapult the industry to the next level. As a result, I believe that there must be marketability value in an innovation." Because all five of these experts agreed to supplement the innovation element with this aspect of marketability (CEP), this study decided that two key aspects of this module, namely the innovation element and the CEP element, are kept.

The second code that comes from these interview findings is the requirement to provide proper direction for merging these two critical parts. All experts decided to construct a learning module that included these two critical features, as well as a STEM approach. Thus, the study intends to apply STEM-conceptualized innovations, where science refers to the application of the notion of Chemistry for pre-university students. Expert 1 says that the combination of these aspects should provide a guide on how to generate advances in STEM domains that are complimented by economic value or marketability. As an introduction, Expert 3 also stated that

this module should be loaded step by step with the preparation of the fundamental innovation initially, and then newly developed to a more challenging degree.

Module Needs Analysis Questionnaire

The purpose of this questionnaire is to gather quantitative and qualitative data from a sample of 40 pre-university lecturers to answer the question of the need for module development components. This component includes the module's element items as well as the module's primary content. The questionnaire is divided into four sections: (1) Section A collects lecturer demographic data such as gender, ethnicity/descent, and experience teaching Chemistry at the pre-university level, (2) Section B contains seven questions that collect module construction element requirements data, and (3) Section C contains seven questions that collect module construction element requirements data. (3) Section C collects required data for the module's primary material, and (4) Section D includes qualitative data to which the lecturer might offer further suggestions for completing the module.

The quantitative data was then evaluated descriptively, whilst the qualitative data, which included recommendations and reviews, was studied using content analysis. The results of this instrument are as follows.

Section A: Lecturer Demographic Data

About 35 (or 87.5 percent) of the 40 lecturers were female, while the remaining five (12.5 percent) were male. A total of 33 people (82.5%) is of Malay heritage, four are of Chinese descent (10.0%), and the remaining three (7.5%) are of Indian descent. A total of 82.5 percent, or 33 people, have more than 10 years of experience teaching Chemistry at the pre-university level, 15.0 percent, or six people, have between 5-10 years, and the remaining 2.5 percent is the only one who has fewer than five years.

Section B: Module Construction Element Requirements

This section comprises seven elemental required items in module construction for which each lecturer must choose one scale from a set of five Likert scales. The results are shown in Table 2.

Table 2. Findings of Module Construction Element Requirements

Questionnaire item	Likert Scale Frequency									
	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
	N	P (%)	N	P (%)	N	P (%)	N	P (%)	N	P (%)
1) STEM approach should be implemented in Chemistry Education.	15	37.50	21	52.50	4	10.00	0	0.00	0	0.00
2) Pre -university students need to master Higher Order Thinking Skills (HOTS) in Chemistry Education.	14	35.00	22	55.00	3	7.50	1	2.50	0	0.00
3) Innovation element in STEM approaches is necessary.	17	42.50	19	47.50	2	5.00	2	5.00	0	0.00
4) Entrepreneurship element in the production of innovation is necessary.		17.50	20	50.00	13	32.50	0	0.00	0	0.00

Questionnaire item	Likert Scale Frequency									
	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
	N	P (%)	N	P (%)	N	P (%)	N	P (%)	N	P (%)
5) Chemistry education requires pre-university students to be scientifically creative.	14	35.00	22	55.00	2	5.00	2	5.00	0	0.00
6) Chemistry education requires pre-university students to be motivated to learn.	22	55.00	16	40.00	2	5.00	0	0.00	0	0.00
7) A guide is required to implement combined STEM innovation and Chemical Entrepreneurship.	22	55.00	15	37.50	1	2.50	2	5.00	0	0.00

Note: N= number of samples, P=percentage

According to Table 1.2, all items have a scale 4 and scale 5 dominance, namely the Agree scale and the Strongly Agree scale. This shows that majority of the sample agreed with the elements needed for the i-CEP Module development.

Section C: Module Primary Content Requirements

This section lists ten of the module's main content requirements. In this section, the lecturer must select "Yes" or "No" for each of the ten content criteria. The results are presented in Table 3.

Table 3. Findings of the module's primary content requirements

Questionnaire Items	Yes		No	
	Quantity	Percentage (%)	Quantity	Percentage (%)
1) Objective / Learning Outcomes	40	100.00	0	0.00
2) Module Usage Guide	40	100.00	0	0.00
3) Reinforcement Activity	39	97.50	1	2.50
4) Assessment Test	40	100.00	0	0.00
5) A step -by -step guide to produce innovation	39	97.50	1	2.50
6) Report Preparation Guide	38	95.00	2	5.00
7) Student Worksheet	37	92.50	3	7.50
8) Prototype Evaluation and Presentation Rubric	40	100.00	0	0.00
9) Student Reflection	40	100.00	0	0.00
10) References	38	95.00	2	5.00

Table 1.3 reveals that the option "Yes" rather than "No" dominates all ten elements. This shows that most of the sample agreed to include all ten things in the learning module that would be created, and that it would be adapted to the layout and demands of the learning subject.

Section D: Additional Recommendation

This section is optional, although it is included to solicit further recommendations from lecturers as a supplement to the module. Here are the five additional recommendations:

Recommendation 1 : "The assessment part, if possible, should be open-ended style

because pre-university students have a relatively high level of Bloom's cognitive thinking ... give a little freedom for students in building their own creativity".

- Recommendation 2 : "The module is linked to the elements of Green Technology in conserving the environment".
- Recommendation 3 : "Based on the reflection of STEM modules that have been built before, researchers need to improve the elements that are lacking so that this module can be fully applied".
- Recommendation 4 : "Examples of STEM learning innovations in chemistry".
- Recommendation 5 : "Usage of flow chart".

After a focused formative evaluation of the analysis phase with three experts, all five of these recommendations were accepted and included in the compilation of the module material.

Student Needs Analysis Questionnaire

As with the module requirements questionnaire given to the lecturers, this questionnaire also has the same items. However, it is processed according to the level and needs of students. The sample of students involved was a total of 60 pre-university students of science stream who had criteria equivalent to the actual sample. There are four sections in this questionnaire, namely (1) Section A, collects student demographic data, (2) Section B, contains seven questions that collect module construction element requirements data, (3) Section C, collects module main content requirements data, and (4) Section D, is an additional recommendation to complement the module, and this data is an open response and not mandatory.

Section A: Student Demographic Data

Out of the 60 students, 42 (70.0%) were female, while the remaining 18 (30.0%) were male. All students, or all students of Malay ethnicity, are based on that value. A total of 30.0 percent, or 18 people, have a B+ grade achievement in Chemistry in secondary level, 40.0 percent, or 24 people, have a B- grade achievement, 20.0 percent, or 12 people, have a C+ grade achievement, and the remaining 10.0 percent, or six people, have a D grade achievement.

Section B: Module Construction Element Requirements

This section comprises seven module construction elements required. To ensure that students submit accurate answers, definitions of concepts such as HOTS, scientific creativity, learning motivation, innovation, and entrepreneurship have been included in the questionnaire's introduction section. The results of the questionnaire are shown in Table 4.

Table 4. Findings of module construction element requirements

Questionnaire item	Likert Scale Frequency									
	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
	N	P (%)	N	P (%)	N	P (%)	N	P (%)	N	P (%)
1) I think STEM approaches should be implemented in Chemistry Education.	32	53.33	25	41.67	3	5.00	0	0.00	0	0.00

Questionnaire item	Likert Scale Frequency									
	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree	
	N	P (%)	N	P (%)	N	P (%)	N	P (%)	N	P (%)
2) I need to master Higher Order Thinking Skills (HOTS) in Chemistry Education.	48	80.00	10	16.67	2	3.33	0	0.00	0	0.00
3) I think innovation element in the STEM approach is necessary.	53	88.33	5	8.33	1	1.67	1	1.67	0	0.00
4) I think the entrepreneurship element in the production of innovation is necessary.	37	61.67	11	18.33	10	16.67	2	3.33	0	0.00
5) I need to be scientifically creativity in Chemistry Education.	19	31.67	33	55.00	7	11.67	1	1.66	0	0.00
6) I need to have learning motivation in Chemistry Education.	43	71.67	17	28.33	0	0.00	0	0.00	0	0.00
7) I need a Chemistry learning guide/module that applies STEM innovation and Chemical Entrepreneurship.	50	83.33	6	10.00	4	6.67	0	0.00	0	0.00

Notes: N=number of samples, P=percentage

According to Table 1.4, most students agree by selecting scale 4 = “Agree” and scale 5 = “Strongly Agree” for all seven questions in this section. As a result, in building the module, our study considered all the above needs.

Section C: Module Primary Content Requirements

This section listed 10 items representing primary content requirements of the module. The following Table 5 shows the findings obtained.

Table 5. Findings of the module's primary content requirements

Questionnaire Items	Yes		No	
	Quantity	Percentage (%)	Quantity	Percentage (%)
1) Objective / Learning Outcomes	49	81.67	11	18.33
2) Module Usage Guide	57	95.00	3	5.00
3) Reinforcement Activity	50	83.33	10	16.67
4) Assessment Test	53	88.33	7	11.67
5) A step -by -step guide to produce innovation	60	100.00	0	0.00
6) Report Preparation Guide	60	100.00	0	0.00
7) Student Worksheet	55	91.67	5	8.33
8) Prototype Evaluation and Presentation Rubric	59	98.33	1	1.67
9) Student Reflection	47	78.33	13	21.67
10) References	49	81.67	11	18.33

Table 5 shows that most students chose "Yes" for all the primary content requirement elements of the courses indicated in the questionnaire. This demonstrates that students require a comprehensive guide, with the highest proportion (100%) reported for two items: (i) a step-by-step guide to produce innovation, and (ii) report preparation guide. Thus, i-CEP Module will highlight the concept of how students want to begin generating innovations and what stages or action plans they will take to make innovations, as well as how to write reports. Thus, all ten items will be displayed in the i-CEP Module and sorted subsequently based on the module validity experts' suitability and improvement recommendations.

Section D: Additional Recommendation

This section is not mandatory but is provided to obtain additional recommendations or suggestions from students as a complement to the module. Out of the 60 respondents, only two recommendations were received. Here are two additional recommendations: Recommendation 1: "Content is more interactive and attracts students" and Recommendation 2: "Colorful". Both of these recommendations were considered and incorporated into the compilation of the module content. This is done after the formative evaluation of the analysis phase, conducted in a focused manner with three experts mentioned earlier.

DISCUSSION

Through the interview findings, we found that it is suitable to apply STEM approach in pre-university Chemistry Education. Numerous countries around the world also have incorporated STEM approach into their curricula to help students acquire the knowledge, skills and values needed for a better students' development (Selisne et al., 2019; Serdyukov, 2017; Yilmaz et al., 2018). The results of the interview analysis also agreed that innovation element is suitable in efforts to improve HOTS mastery, scientific creativity, and learning motivation among pre-university students in the science stream. As mentioned by Ah-Nam and Osman, (2017), and Cook, (2018) STEM translate theories into practice, products, and innovations. Studies conducted shown students exposed in STEM approach activities, have foster not only their knowledge of that particular subject involved, but also they acquired skills in problem-solving, in a creative way and possess more enthusiasm (motivated) during the lesson from those who are not expose (Mohd Shukri et al., 2019; Phetsirin Tunkham et al., 2016; Shahali et al., 2017).

The theme derived from the thematic analysis using ATLAS.ti version 22 helped us to finally conclude the suitability of innovation and entrepreneurship in our module development. Because the study is focused on Chemistry, the notion of entrepreneurship employed will be Chemical Entrepreneurship. The analysis' conclusions also point to the suitability of combining innovation aspects with CEP in the construction of this study module. Experts also advised that the module effectiveness study be carried out at the start of the semester (semester one) to reduce the risk of data validity.

As for the Module Need Analysis of Questionnaire and Student Need Analysis of Questionnaire items, there is a need for the development of instructional guide materials or learning modules that incorporate elements of innovation and CEP, where the module should also integrate STEM in Chemistry learning, apply learning activities involving HOTS, scientific creativity, and learning motivation.

CONCLUSION

This study has clearly discussed the initial step of the i-CEP Module development, through the analysis phase according to the ADDIE Model. Based on results obtained in this line of research, the findings are considerably remarkable in determining the further steps in ADDIE for

the module development, namely the design phase, development phase, implementation phase, and the evaluation phase, which will be described in the future article. In the discussion section, The findings have successfully answered both research questions: (1) it is suitable to apply innovation and Chemical Entrepreneurship element for pre-university students of science stream, and (2) the components required in the development of the i-CEP Module shall comprise of seven requirements for the module construction and ten requirements for the module primary contents. The seven requirements for module construction are (i) STEM approach in Chemistry Education, (ii) HOTS in Chemistry Education, (iii) STEM innovation, (iv) entrepreneurship in innovation, (v) scientific creativity in Chemistry Education, (vi) learning motivation in Chemistry Education, and (vii) guides of STEM innovation and Chemical Entrepreneurship. Whereas ten requirements for the module primary contents are (i) objectives/learning outcomes, (ii) Modules User Guide, (iii) reinforcement activity, (iv) assessment test, (v) a step-by-step guide to produce innovation, (vi) report preparation guide, (vii) student worksheet, (viii) prototype of evaluation and presentation rubric, (ix) student reflection and (x) references. The current formulated analysis phase study is a success and further ADDIE steps can be performed to develop i-CEP Module to be validated and tested its effectiveness on increasing HOTS, scientific creativity and learning motivation towards Chemistry Education among pre-university students. Lastly, it is expected that this analysis phase project and findings may assist other researchers or educators to run their own analysis in developing a module or any educational instructions.

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