STEAM-ing Criteria: Best Criteria for Integrating Science Module with Visual Art

Siti Soraya Ramli [1*], Siti Zuraida Maaruf [2], Nabilah Abdullah[2]

[1] SM Sains Alam Shah, Jalan Yaacob Latif, Bandar Tun Razak, 56000 Kuala Lumpur
sorayaramli@gmail.com
[2]Faculty of Education, Universiti Teknologi MARA,
UiTM Puncak Alam Campus, 42300 Puncak Alam, Selangor, Malaysia
sitiz610@uitm.edu.my
nabil789@uitm.edu.my
[*]Corresponding Author

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Abstract: STEM subjects (Science, Technology, Engineering and Mathematics) are widely recognised for a country's development. In Malaysia, integrating arts into STEM education started over 20 years ago with the introduction of KBSR and KBSM. However, some worried that art could divert focus from core STEM skills. This research aims to develop an effective Science module by consulting experts. The module to be developed has gone through the need analysis phase from secondary students and teachers. They faced challenges teaching and learning about energy and sustainability. However, they agreed that arts could aid understanding. In this study, the researcher interviewed six science lecturers, visual art lecturers and curriculum developers in the design and development phase. The semi-structured interview consists of six main questions: Demographics of respondents, Visual Arts Aids, supporting materials, Teaching techniques, Activities, and Exercises suitable to design and develop the Science module. This phase is intended to gather the aspects to be considered in selecting a suitable teaching technique, genre, level, context, the ability of the students, duration of the lesson, and teacher's experience. The experts shared information on the curriculum aspect, such as evaluation, learning outcome, duration of the implementation, and other resources. Other than that, the experts also offered pieces of information on the design and technical aspects of the module. These interviews are transcribed, and the themes that arise from the interview are used to design the Fuzzy Delphi Method (FDM) instrument. The experts said that thoughtfully integrating visual arts can help students comprehend complex concepts. However, they stressed that art must directly connect to scientific principles. It should complement, not obscure, the STEM focus. With this guidance, the module can leverage the arts to engage students while maintaining rigour. Experts emphasised striking the right balance - using art to reinforce STEM, not displace it. Their insights will shape an integrated curriculum to equip students for the future.

Keywords: STEM Education, Visual Art, Interdisciplinary Teaching, Science Module, Creativity

1. Introduction

The Malaysian Education Ministry has emphasised integrated learning to develop a scientifically and technologically progressive society. This approach encourages a multidisciplinary perspective that promotes innovation, creativity, and critical thinking. The integrated approach also helps students to understand how different areas of knowledge relate to each other, providing them with

a deeper appreciation of the scientific and technological advancements that shape the world. Malaysian school curricula still retain the idea of integration across subject matter, although the emphasis has since shifted to a standard-based one. It was recently exposed that the existing amount of science stream students' enrolment mounted at only 19 percent out of about 447,000 PT3 candidates when they enrolled for Form Four level (Khan, 2020)

Although an integrated curriculum exists, learning and teaching in Malaysian schools remain mostly segregated by subject areas, resulting in a fragmented approach. Consequently, these pressures have resulted in a didactic and mechanical approach to learning and teaching, which neglects the underlying values of incorporating diverse subject areas into the curriculum, such as language and art, into science teaching to promote a more holistic approach to learning. Earlier, it was noted that the lack of hands-on learning opportunities, potentially stemming from teachers' inadequate pedagogical and technological skills, has caused worry among different parties about students' proficiency in problem-solving, computational thinking, and critical thinking (Khairani, A. Z., 2016). Developing a high-quality science module that effectively integrates visual art requires the input and expertise of professionals in both fields. Experts in science and visual art education can help the researcher develop a module that is both engaging and informative, using strategies that promote students' critical thinking, problem-solving, and creativity. Teachers can also benefit from experts' knowledge and experience in designing effective instructional strategies, assessing student learning, and integrating technology into teaching practices. Ultimately, this collaboration can lead to a more comprehensive and engaging learning experience for students, improving their retention and understanding of scientific concepts.

During the Bett Asia Leadership Summit and Expo 2019, former Education Minister Dr Maszlee Malik noted that there has been an average decline of six thousand STEM students annually from 2012 to 2018 (Ibrahim, 2019). The Ministry of Education (MOE) has compiled various data and studies which indicate that the decline in the number of students in the science stream is due to four contributing factors. One of these is an ineffectual curriculum. According to the Malaysia Education Blueprint 2013-2025, the current STEM curriculum is overly focused on presenting facts and information without emphasising the practical application of knowledge in everyday life. As a result, students cannot recognise the usefulness and relevance of STEM subjects to their lives.

The lack of awareness of the significance of science and technology in real-world situations has also been identified as a reason for the lack of interest in STEM. Although the Ministry of Education has made efforts to promote STEM education through various learning packages, there are still reports that students at all levels do not fully grasp STEM subjects and struggle with understanding various concepts (Ismail et al., 2019; Maruthai, 2019). This issue may also be attributed to the teachers' knowledge and pedagogical skills since they are primarily responsible for introducing, explaining, and demonstrating the importance of science and technology for the betterment of humanity.

Another factor contributing to the decline in STEM student numbers is related to the students' perceptions and career choices. Research conducted by Kamsi et al. (2019) revealed that undergraduate students perceive the demand for STEM workers to be high and the expectations to be even higher. Pursuing a career in STEM is also viewed as more complex, with a greater likelihood of poor performance and dropping out of university. Furthermore, students' choice of academic programs and career paths may be based on inadequate information about STEM professions (Mohtar et al., 2019), which echoes Holman and Finegold's (2010) assertion that students' negative views of STEM are mainly due to a poor understanding of the skills, job prospects, and qualifications related to STEM fields. Consequently, students may not be attracted to STEM professions (Wyss et al., 2012).

According to the Ministry of Education, the quality of teaching and learning is one of the reasons for students' lack of interest in STEM subjects. Several studies have shown that many science educators struggle to comprehend and link STEM concepts across the STEM disciplines (Siew et al., 2015; Ramli & Talib, 2017; Mahmud et al., 2018; Fadzil et al., 2019). Teachers' lack of creativity, innovation, and knowledge in performing experiments and other hands-on activities could be due to training shortcomings (Azman et al., 2018). Saat et al. (2021) reported that teachers lacked confidence in conducting experiments due to a deficiency in training, while scientists involved in the same project agreed that teachers lacked the latest scientific skills. Large class sizes (of 40 to 50 pupils per class) and poorly equipped classrooms also hamper the quality of teaching and learning in STEM classes (Thomas & Watters, 2015). This issue has been highlighted in several studies, including those by Ramli et al.

(2013), Ariffin, A. (2014), Cheok and Wong (2014), and Nalini et al. (2019). The absence of knowledgeable and skilled teachers and science facilities and resources can also disrupt the quality of STEM subjects (Agolla et al., 2018).

The significance of teachers in addressing STEM education challenges is clear. Teachers must deliver lessons with clarity, enthusiasm, and passion to enable students to comprehend the subject matter and develop a keen interest in pursuing STEM as a career. The Social Constructivist theory of Vygotsky, which is the basis of this research, is deemed appropriate as it emphasises the facilitative role of teachers in promoting cognitive and behavioural changes in and out of the classroom. To enhance instruction, teachers can use appropriate resources, media, and other teaching aids to support learning.

Several studies have emphasised the importance of incorporating art elements to improve science teaching and learning. Bequtte and Bequette (2012) suggested that artistic mediums such as creative processes and design thinking can be utilised to solve scientific problems. Similarly, Colucci-Cray et al. (2016) proposed that incorporating creative approaches through STEAM (Science, Technology, Engineering, Arts, and Mathematics) supports conceptual thinking in science education. Art and its creative processes can help students explore and develop multiple intelligences. However, there is a consensus among education experts that more empirical evidence and literature are needed to establish the effectiveness of art-based activities and creativity in enhancing science education.

Since the teachers are the front-liners of education, their feedback in the need analysis phase cannot be ignored. To fulfil these wishes, an ideal science module should be developed accordingly Malaysian education moulded by consulting education experts in science and visual art education are essential for effective teaching and learning. Education experts possess expertise in pedagogy, knowledge of curriculum standards, and understanding of diverse learning needs, can provide quality assurance and offer professional development opportunities. This approach ensures that the modules are practical, well-aligned with learning outcomes, cater to diverse learners, are high quality, and teachers are trained to use them effectively.

2. Research Objectives

Based on the concerns highlighted, this study was carried out with the following objectives:

1. To identify the experts' opinions on the visual art aids and support materials, appropriate activities, and exercises that can be integrated into the module.
2. To investigate the experts' views on suitable teaching techniques that can be applied in the module.
3. To know the reasons experts gave such recommendations for each criterion.
4. To design and create the Science module in teaching and learning Science subjects for lower secondary students based on the experts' advice.

3. Methodology

This study aims to determine experts' consensus on identifying the themes to design the Fuzzy Delphi Method (FDM) instrument. FDM combines the Fuzzy set theory and the traditional Delphi method to overcome the weakness of the existing Delphi method. The concept of combining traditional Delphi and Fuzzy theory was introduced by Ishikawa et al. (1993) to improve the Delphi method's vagueness and the results' stability (Tadic et al., 2015). Zadeh (1965) introduced a set of fuzzy data to manipulate data, defined as non-statical uncertainties.

Fuzzy set theory is an element with a certain degree of membership. It provides formalised tools to mathematically represent vagueness and ambiguity for dealing with problems with intrinsic imprecision (Cehn et al., 2017). Therefore, this study consists of several survey rounds to gain acceptable decisions based on experts' consensus and would be able to shorten the survey process time (Gulistan Ahmad, 2016).

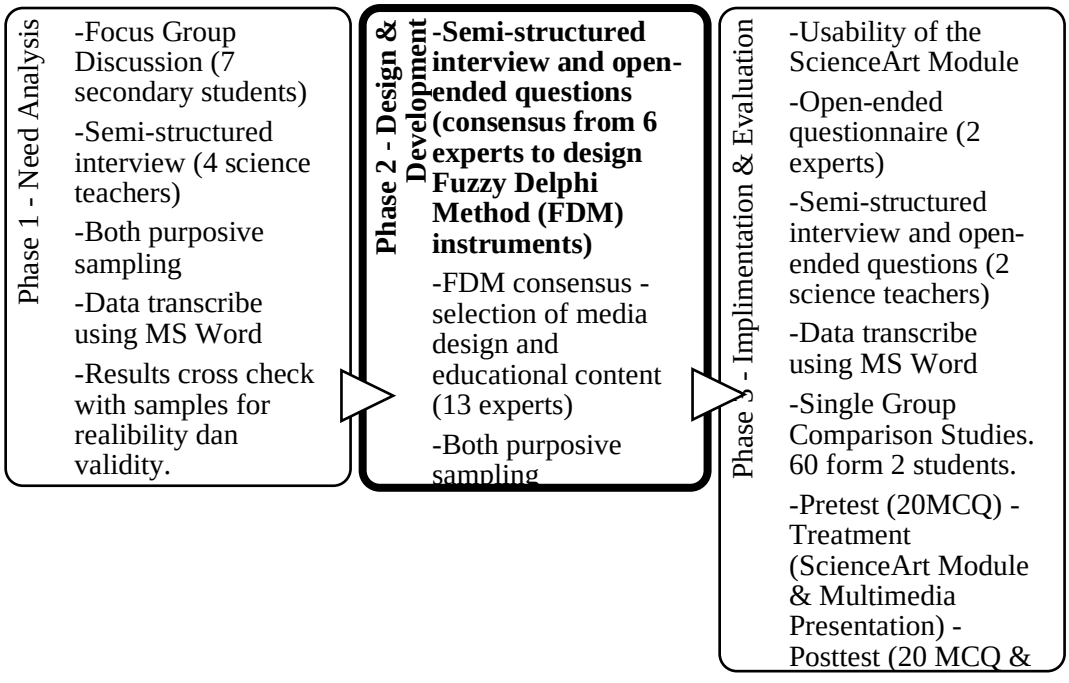
Experts in these studies are defined as informed individuals who know about a specific subject. According to Baker et al., 2006, an expert is a person who is very knowledgeable and skilful in a particular area, which in this study refers to subject matter experts. Since combining science and art education in school modules is quite new in Malaysia, the number of experts available is limited.

Supported by Saaty & Ozdemir (2014), the number of experts assigned is not necessarily high. Mat Noh et al. (2019) mentioned that adding more or less experienced experts may weaken the results' accuracy. There is no strong relationship between the number of experts and the quality of the decisions that could be generated from the group. Six to 20 participants, depending on the topic, is enough for FDM experts (Clayton, 1997; Rowe & Wright,2001). The researcher chooses experts from a combination of knowledge and expertise that reflects the full scope of the problem domain. Diverse experts were preferable to experts focused on a single speciality, which in this study was the science combined with an art module in learning science. This study managed to get six experts - one curriculum lecturer, two visual art lecturers, and three science lecturers. The participants in this phase were all senior government university lecturers with 10-25 years of field experience. This is to ensure they meet the criteria as knowledgeable respondents.

Semi-structured interviews were the primary data collection method used in this research. To validate the questions, the interview protocol developed by the researcher was reviewed by visual art and science education experts before conducting the interviews. Participants were first contacted by phone to explain the research aims. Those agreeing to participate were emailed consent forms and further details. Due to participant's busy schedules, most interviews were conducted via video calls. To avoid influence between experts, the interview is done individually. Before starting, the research's goals, purposes and significance were recapped. Experts were told that the sessions would be recorded for academic use only. Interviews lasted 1-1.5 hours and were transcribed in Word. To enhance reliability, transcriptions were discussed with experts to confirm that their perspectives were correctly captured. The data collected offer critical perspectives on integrating visual arts into STEM education.

Figure 1

Phases and Development Research



4.0 Findings and Discussion

4.1 Visual Art Aids and Techniques That Can Be Integrated into the Science Module

The experts admitted that many visual art aids and techniques can be used. The key is to choose a technique that best suits the concept and the students being taught. These are the aids and techniques

suggested by the experts. Four experts mentioned that video and graphics/diagrams/illustrations are suitable Visual Art Aids that can be integrated into the Science module.

> *There are many of them, such as cartoons and animation, as well as Simulations.*
> *For me, animation and videos such as stop-motion and comics are suitable to show the process of the learning topic. (Expert 1)*

> *I think Video and Graphics are the most important...*
> *Visual arts elements act like a stimulus for a student that maximises the usage of senses, using colourful graphics, songs, or animation of science procedures. They must be combined in teaching and learning science. The usage of these components can maximise the engagement of students. (Expert 2)*

> *Most important is video compared to the other (Expert 4)*

> *For me, text and graphics are the most important element.*
> *By using model, Illustration and animations. (Expert 5)*

> *Video, Audio, and Graphics are a very important combination.*
> *The usage of videos such as the courseware that I mentioned before. However, the video is overly formal and heavy for the students to understand. So, it would be easier if there were another module that integrates animation and concept-exploration elements that are lighter and more leisurely for students. (Expert 6)*

4.2 Support Materials that Can be Used in Developing Science Module.

The experts reminded us that it is essential to note that different students may have different learning styles and preferences, so providing various materials and activities that cater to different learners is essential. As the module will be for lower secondary students, it is also essential that the materials provided are appropriate for their age and cognitive level. Several types of support materials can be used in developing a science module for lower secondary students shared by the experts.

Infographics are powerful tools for showing data and information in an easy-to-digest format and explaining scientific concepts and data. Video resources such as video lectures, animations, and simulations can supplement the material covered in the textbook and help clarify complex concepts.

> *Infographics, videos, comics, and pictorial books are suitable as support materials in developing this module. (Expert 2)*

> *In my opinion, Infographics, Picture books, and Videos are very suitable as support materials in developing the module. (Expert 5)*

> *I Choose Infographics, animations or videos, and pictorial manual books as appropriate support material for this module. (Expert 6)*

> *QR-Code and infographic. I propose pocket notes with QR-Code for teachers' reference with collections of clear and precise material for every topic slide. (Expert 3)*

Sketch notes can be used to organise and summarise the research findings' key points visually. They can also present the findings concisely, making them easy to understand and remember.

> *Sketch noting is also interesting. (Expert 1)*

Audio materials such as audio lectures and podcasts can supplement the textbook's material and provide an alternative way of presenting the information.

Audio-visual based on the animation or video that is being developed must have subtitles and focuses on the concept that is being learned. (Expert 6)

Assessment tools such as quizzes, tests, and evaluations can assess students' understanding and progress throughout the module.

Evaluation material also needed. (Expert 2)

Using real-world examples of scientific concepts, such as news articles, scientific experiments, or case studies, can help connect the material to students' everyday lives and make it more relevant and interesting.

The most suitable support materials are animation videos that have virtual reality element. (Expert 4)

4.3 Key Features in Support Materials

In order to make a module and learning session successful, there are several **key features** that teaching and learning **support materials** that the experts mentioned should include:-

User-friendliness is a key feature of teaching and learning support materials, as it can improve their ease of use and accessibility, making them more likely to be used by teachers and students and helping to reduce frustration and confusion.

User-friendly, less hassle by removing the need for passwords and restricted access that gives access to certain devices only. (Expert 4)

Okay, user-friendly, clear outcomes, and not confusing to the consumer. (Expert 5)

Engaging and interactive: The materials should be engaging and interactive, as they can help to increase student motivation and participation. This can be achieved using colourful illustrations, animations, videos, games, etc.

Interactive (Expert 1)

Differentiation: The materials should be designed with differentiation in mind to accommodate the needs of all students, whether they are struggling, on grade level, or advanced.

Must have audio, visual, and text elements to tackle the learning styles of the students. (Expert 6)

Clear explanations and illustrations: The materials should provide clear explanations and illustrations of the key concepts and skills being covered in the module. This will help students and non-option teachers better understand the material and retain the information.

The main feature is material that helps non-option teachers in delivering Science and Visual Art Education, such as illustrated manuals. (Expert 3)

Flexibility: The materials should be flexible and adaptable so that they can be used effectively in various teaching contexts and can be tailored to the needs of different students and classrooms.

Involves technology and easy to access. (Expert 2)

4.4 Best form for developing Science Module

The researcher suggested combining softcopy and hardcopy materials. This can provide students with various resources to support their learning and allow them to choose how they want to access and consume the materials.

> *Both. The students must engage in tactile activities and not just focus solely on laptops, gadgets, and mobile phones. (Expert 1)*

> *Both are important, in all situations. Depends on the student's location because some places do not have good technological facilities. (Expert 2)*

> *Both. Softcopy is generally easier to store and use, while hardcopy is for, like, the usage of teachers for documentation. (Expert 4)*

> *I would say both to cater to the different student's abilities. (Expert 5)*

4.5 The Role of Teaching and Learning Support Materials.

The teaching and learning support material can help teachers and students use the module. It can enhance instruction by providing clear explanations, illustrations, and examples of key concepts and skills that are covered in the module. This can help clarify difficult material and make it more engaging for students.

> *These supporting materials are an aid to increase students' understanding of the subject. (Expert 1)*

> *Help students to comprehend better. (Expert 5)*

Teaching and learning support materials are also believed to *support distance or blended learning*. In these scenarios, the materials can be used to support learning remotely and provide access to the module's content, activities, and assessments.

> *To be widespread then given a user manual, and a link to a google drive so that can be sought by the teachers, no matter where they are. (Expert 2)*

> *Easy to access, like at the tip of our fingers anywhere we are. (Expert 6)*

It can also *support different learning styles.* The materials can provide a variety of activities and materials that cater to different learning styles so that all students and teachers can benefit from the module regardless of their learning preferences.

> *Making the developed module as a core and easily accessed module better than the materials in the current market. Other than making the module more user-friendly, especially for the non-optional teachers. Makes visual art activities an idea to cross into other subjects, especially science. (Expert 3)*

Ultimately, teaching and learning support materials can help support the module and the learning experience by providing clear explanations and supporting different learning styles. They can also allow the teacher to adapt to the student's needs, make the lesson interactive and engaging, and support remote and blended learning situations.

4.6 The Appropriate Teaching Techniques to be Used in the Teaching and Learning of Science in Lower Secondary School.

The most important thing is that the teaching techniques are aligned with the curriculum standards and effectively implemented to support the students in their learning process. Small group discussion, problem-solving, case studies, Q&A sessions, and scenario-based learning are all teaching techniques suggested by the experts that can be used to develop a ScienceArt module for lower secondary students to learn Science.

> *A lot, for Small Group Discussions, Problem Solving, Case Studies, Drills, and Q&A sessions are perfect. I also suggested scenario-based learning - a bit different from the case study. (Expert 1)*

> *All activities that involve authentic tasks, appropriate to the background that students bring, for example, small group discussions. (Expert 2)*

> *Question inquiry and discussion in small groups is sufficient for junior high school students and cross-subject. Link some other subjects to the subject being taught. Examples of science and medicine illustrations. (Expert 3)*

> *Can do Q&A sessions, small group discussions, problem-solving, and individual case studies. (Expert 5)*

> *Appropriate if using inquiry questioning and small group discussion. So, problem-based learning involves the teacher acting as a facilitator. Teachers must take control of the class and bring simple problems and analogies to relate to the topic that will be covered. Let the students think. Then, start the lesson to explain the situation. Support material will help students to have a better understanding. (Expert 6)*

4.7 The Form of Activities Suitable for the Development of the Science Module for Lower Secondary Students in Learning Science.

These activities should be engaging, interactive, and aligned with the curriculum standards to help students understand and apply scientific concepts and skills. Based on the experts' responses, the module activities are small group discussions. These activities will involve students discussing and debating scientific ideas or issues, which can help to develop critical thinking skills and scientific literacy. They also can do concept mapping, which involves creating a visual representation of the relationships between different scientific concepts to help students understand the connections between different ideas. Lastly, online and digital resources such as simulations, interactive quizzes, videos, and games provide students with an interactive and engaging way to learn science.

> *…it would be more interesting if there were mind mapping and brainstorming using artwork: wall art, murals, and posters. (Expert 1)*

> *Students can find information on the internet individually and then discuss in small groups. (Expert 2)*

> *Preparation of existing science materials in visual art classes as well as experimental techniques of materials between science and art are combined according to the title. Then a discussion can be held in smaller groups. (Expert 3)*

> *Students can search for information individually on the internet, and the information can be discussed in Google Meet or Zoom with a small circle of friends. (Expert 4)*

They can make online discussions. (Expert 5)

Answering quizzes using computers. For example, simple experiments and STEM activities related to the topic taught. (Expert 6)

4.8 Appropriate Exercises for the Development of a Science Module for Lower Secondary Students.

The experts suggested quizzes and creative notes as appropriate exercises. Students can also give a presentation in front of the class using multimedia. These exercises should be designed to be engaging, interactive, and aligned with the curriculum standards to help students understand and apply scientific concepts and skills.

They can do quizzes, produce products in groups or individually, make observations and produce mind maps or creative notes. The exercise is related to the Science poster for my home/community involving the family or residential area. (Expert 1)

Pupils make folios, the development of Science simulations with the help of multimedia, also produce ideas or creative notes and produce products in groups or individually.(Expert 2)

Exercises include making folios, developing products individually or in groups, developing science simulation with multimedia, and creating creative notes. In addition, the teacher can also guide the drawing of basic shapes that are often and necessary in science. (Expert 3)

Students can make a science simulation with the help of multimedia and present it, and others can make creative notes after listening to their friends' presentations. After that, all of them answered the quiz for the assessment of the topic. (Expert 4)

Make science paperwork, observe, produce products in groups or individuals such as a folio. Then, make creative notes. All these hands-on and immersive activities will help to engrave information to long-term memory more easily and easier to be retrieved. (Expert 5)

Suitable exercises for this module are quizzes, making group or individual products, observation, and presentation of assignments in front of the class. They can produce a creative presentation based on the topic in the science lesson taught. (Expert 6)

Based on the experts' suggestions, a successful Science module for lower secondary students should incorporate a variety of visual art aids and techniques, including videos, graphics, diagrams, and infographics. The module should be user-friendly and combine soft and hardcopy materials for different learning styles. Teaching techniques should include small group discussions, problem-solving, case studies, and scenario-based learning, all aligned with curriculum standards. Activities like concept mapping and online resources such as simulations and interactive quizzes can enhance engagement. Exercises may include quizzes, creative notes, and multimedia presentations. The key is to provide diverse, age-appropriate materials that support different learning preferences, clarify complex concepts, and make the learning experience interactive and engaging while being adaptable for remote and blended learning situations.

Figure 2

Front cover of the SciArt Module

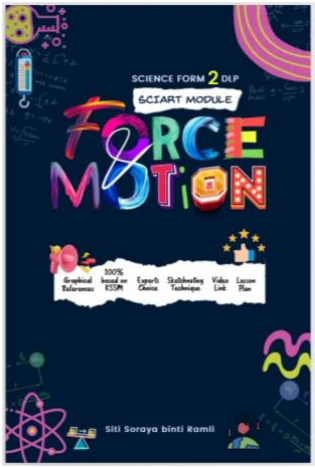


Figure 3

Introduction page. The researcher used the sketchnoting technique to simplify the information

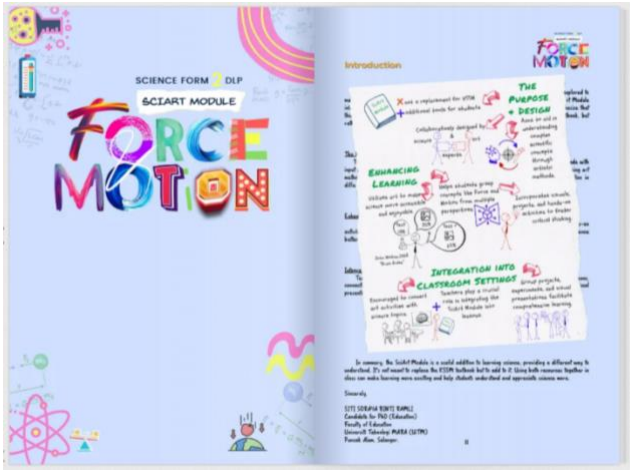


Figure 4

Comics and Infographics mainly used in the module

Figure 5

Activities in the module included Sketchingnoting Technique for creative notes and quizzes in line with the experts' suggestion

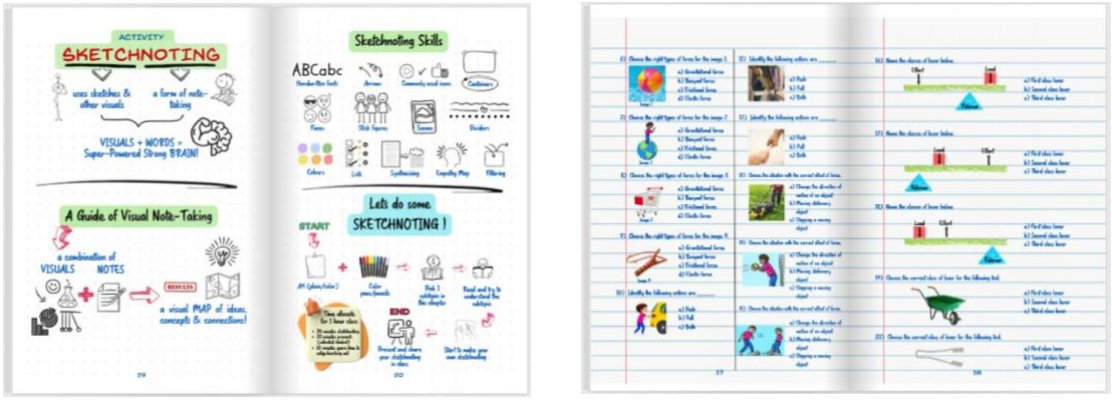


Figure 6

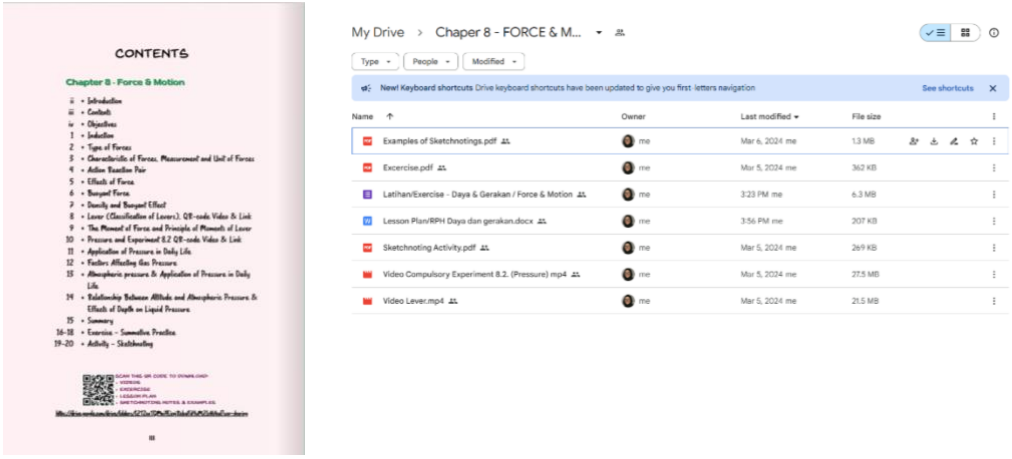
Examples of students' activities

Figure 7

Small group discussion among the students

Figure 8

QRCode and link to connect the user to Google Drive, where all the information is gathered



5. Conclusion and Suggestions

To develop an ideal science module based on the need analysis done in a previous phase, it is essential to develop high-quality educational modules that are effective, engaging, and accessible to all learners. This is especially important in science education, where students must deeply understand complex scientific concepts and develop critical thinking and problem-solving skills. Fortunately, by following the best criteria recommended by education experts, researchers hope for a good science module that can meet the needs of today's teachers and learners.

One key criterion for developing an effective science module is consulting with education experts. These experts possess the knowledge and experience necessary to develop well-structured modules aligned with curriculum standards and accommodating diverse learning needs. By leveraging their expertise, we can create modules that promote effective learning outcomes and help prepare students for the demands of the modern world. Another important criterion for a good science module is to ensure it is designed with effective pedagogical strategies. This means that the module should use instructional methods that are evidence-based and supported by research in education. For example, the module could incorporate active learning strategies such as problem-based or collaborative learning, which effectively promote student engagement and a deep understanding of scientific concepts.

A good science module should also be interactive and engaging, using visual art and multimedia elements such as videos, simulations, and animations to help students visualise complex scientific concepts. By incorporating these elements, the module can help students better understand the subject matter and retain information more effectively. In addition, a good science module should be designed with accessibility in mind, ensuring that students of all backgrounds and abilities can use it. This means that the module should be designed to consider students with disabilities or different learning styles, such as visual or auditory learners. The module should be evaluated rigorously to ensure it meets the desired learning outcomes and effectively promotes student learning. This evaluation should be ongoing, with feedback from students and teachers incorporated into the module's design to improve its effectiveness and accessibility.

Combining visual arts alongside STEM (Science, Technology, Engineering, and Mathematics) subjects within Malaysia's education system offers a potential area for developing creativity while encouraging problem-solving through a holistic experience. However, this integration comes with its own set of challenges. The successful implementation of this interdisciplinary approach will largely depend on effectively addressing these issues. One of the primary challenges is the need for changes to the existing curriculum, requiring time for both STEM content and visual arts. The Ministry of Education could revise the curriculum for more interdisciplinary learning in state-run schools. Schools could also adopt project-based learning approaches, allowing STEM and visual arts to be naturally

incorporated into long-term projects. Teacher preparedness and resistance to change are significant concerns. To ensure teachers feel competent and knowledgeable, systematic professional development should be implemented. Additionally, cultivating a professional learning community among teachers could support collaboration and best practice sharing, making the integration more feasible and less overwhelming.

Another challenge is resource availability, particularly in rural and underfunded schools. The Ministry of Education could prioritise funding for the resources needed for this integration and consider partnerships with private sector companies or NGOs to provide technology and art supplies. Additionally, using open-source or low-cost resources might make integration even more feasible. Assessment and evaluation are complex, as traditional methods may not fully capture the depth of development from combining visual arts with STEM practices. New assessment tools for imagination, innovation, and creativity should be developed to complement existing standardised assessments, providing a more comprehensive picture of student learning. To overcome varied levels of student engagement and societal devaluation of the arts compared to STEM subjects, a culture of respect for different kinds of knowledge and competencies must be cultivated. This could be achieved through awareness campaigns, showcasing successful interdisciplinary work, and explaining how creativity plays a vital role in STEM.

Policy challenges and alignment with national educational goals need careful consideration. The Ministry of Education can promote and reward interdisciplinary teaching through policy initiatives within an overall system-thinking perspective. Pilot programs could serve as a proof-of-concept to optimise strategies before broader adoption.

Bringing teachers and schools together with external partners is key to successful implementation. Interdisciplinary teams should be established in schools to collaboratively design and teach integrated units. Additionally, partnerships with industries and cultural institutions can provide valuable resources for students.

In conclusion, while integrating visual arts with STEM subjects presents challenges, these can be addressed through sophisticated planning, methodical specialist training, and major shifts in educational tradition. Tackling these obstacles will help create a more competitive and holistic education initiative in Malaysia, preparing students for the real-world challenges of living in today's globalised world.

6. Co-Author Contribution and Acknowledgement

Siti Zuraida Maaruf [2] – Co-Respondent
Nabilah Abdullah [3] – Expert of Science Department

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