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MANAGEMENT FOR THE DEVELOPMENT OF STEM-BASED MIDDLE SCHOOL SCIENCE TEXTBOOKS ACCORDING TO THE CONTEXT OF THE MARITIME AREA

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Abstract:
This research aims to develop a STEM (Science, Technology, Engineering, and Mathematics) based Natural Sciences (IPA) textbook that is appropriate to the maritime context. In the context of education in coastal or maritime areas, science learning needs to be adapted to the characteristics of the surrounding environment, such as marine ecosystems, natural resources, as well as the challenges and potential that exist in maritime areas. The textbook being developed is expected to increase students' understanding of science concepts through an interdisciplinary approach that integrates science, technology, engineering and mathematics. The type of research applied to achieve the research objectives is qualitative research with a descriptive/documentary interview, case study/exploratory approach. The research results show that the developed STEM-based junior high school science textbook is able to improve students' critical thinking and problem solving skills, as well as providing a deeper understanding of local maritime issues. This textbook also succeeds in encouraging students' active involvement in STEM-based experiments and projects that are relevant to everyday life in coastal areas. Overall, the development of this textbook can be an innovative alternative in enriching the junior high school science curriculum in the maritime area, as well as preparing the younger generation who are ready to face global challenges through a contextual and applicable science approach.
Keywords: Development management, junior high school science textbooks, STEM, maritime areas,

INTRODUCTION

Science education in Indonesia, especially at the junior high school (SMP) level, plays an important role in shaping students' understanding of skills in facing global challenges. One approach that is currently receiving great attention is the application of STEM (Science, Technology, Engineering, and Mathematics) concepts in learning. STEM not only integrates various scientific disciplines, but also prioritizes practical aspects that are relevant to everyday life, preparing the younger generation to face various complex problems that exist in the real world. However, in its implementation, the implementation of STEM learning in Indonesia is still faced with various challenges, one of which is the relevance of teaching materials to local conditions and context. Especially in the maritime region, which has abundant natural resources but is still often neglected in the development of STEM-based learning. Maritime regions, with their unique geographic, social and economic characteristics, require a more contextual approach in developing science (Natural Sciences) teaching materials.

Therefore, it is important to develop junior high school science textbooks that are not only STEM-based, but also adapted to the context of the maritime region. The development of this contextual textbook will provide a more meaningful learning experience for students, so that they

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can more easily understand and apply it in their daily lives which are directly related to the potential of the sea and fisheries. It is hoped that this STEM-based textbook can encourage students to be more critical, creative and innovative in utilizing the natural resources around them, while supporting sustainable development in the Indonesian maritime region.

STEM education in maritime areas equips students with the tools needed to address pressing global problems, such as climate change, public health crises, and technological advances. Through activities such as simulations and challenges that mimic real-life scenarios, students learn to apply their knowledge to find appropriate solutions. For example, they work on projects to create energy-efficient devices or develop plans to reduce their school's waste. The application of this knowledge underscores the relevance of STEM in everyday life, enabling students to become proactive contributors to society. As highlighted by the Organization for Economic Cooperation and Development (OECD, 2018), fostering students' ability to apply STEM concepts in practical situations is critical to developing informed citizens who can engage wisely in addressing the complex problems of their time.

This article aims to discuss the importance of management in developing STEM-based junior high school science textbooks that are appropriate to the maritime context. The discussion will cover the processes, strategies and challenges in designing textbooks that are relevant and effective in creating a more contextual and applicable learning experience for students in coastal and island areas.

METHODOLOGY

The type of research applied to achieve the research objectives is qualitative research with a descriptive/case study/exploratory approach. This type of research is applied to uncover phenomena that occur in the research field related to Stem-Based Middle School Science Textbook Development Management in the Maritime Context. Qualitative research is a research method that is based on philosophy and uses researchers as key instruments (Sugiyono, 2023). The research was conducted in schools located in the hinterland of Batam City, consisting of 5 junior high schools and 2 high schools. The subjects of this research were determined using a purposive sampling method so that the information needed came from informants who had knowledge of the substance being studied. The informants for this research consisted of 7 school principals, 20 subject teachers and class teachers who served at junior high school level, 2 school supervisors, and 2 Batam City Education Service officials.

The instrument of this research is the researcher himself, using theory as a measure to understand the situation in the field. Apart from that, researchers also use interview guides so that

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the data collection process takes place effectively and substantively in the field. Below is the interview guide used by the researcher to dig up information related to the management of the development of Stem-Based Middle School Science Textbooks in the context of the Maritime Region in Batam City.

Table 1. Field Interview Guide

NO	ASPECT	RESEARCH QUESTIONS
1	Need	1. What are the needs of students and teachers in learning 2. How can science textbooks be designed to be relevant to local contexts and the latest curriculum?
2	KONTEN	1. What is the validity of the science material in textbooks based on the national curriculum and trusted literature sources?
3	DESAIN VISUAL	1. How can the visual design of science textbooks increase junior high school students' interest in learning? 2. Are the layout and graphic design of textbooks appropriate to the age needs of middle school students?
4	LEARNING STRATEGIES	1. Is the approach [for example, STEM-based, inquiry, or discovery] effective in science textbooks?
5	LEARNING EVALUATION	1. Does the science textbook provide evaluation questions that can measure students' critical thinking abilities? 2. How do textbooks facilitate formative and summative assessments effectively?
6	BOOK EFFECTIVENESS	1. Is the use of developed science textbooks more effective than conventional textbooks? 2. How do students and teachers respond to science textbooks after they are implemented in the learning process?

Data collection for this research was carried out through in-depth interview techniques with 7 school principals, 20 subject teachers and class teachers who work at the junior high school level, 2 school supervisors, and 2 Batam City Education Service officials. Furthermore, researchers also conducted a documentation study to study the policies, regulations and procedures for developing Stem-Based Middle School Science Textbooks in the context of the Maritime Region in Batam City. and to strengthen the data obtained from interviews. Researchers also conducted an

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observation study to see directly in the field the implementation of junior high school science textbook development in the hinterland area of Batam City. This research data was analyzed using the Miles & Hubberman (2014) model which consists of the stages of data display, data reduction, data verification, and conclusion drawing. The research data collected was validated using the tri angulation technique. Apart from that, to find out the validity of the research data, the data confirmation and data credibility stages are carried out to determine the level of truth of the research data collected.

FINDINGS AND DISCUSSION

Management of developing STEM-based junior high school science textbooks according to the maritime context is a topic that involves various dimensions, starting from STEM education approaches, implementing local context-based curricula, to managing the development of teaching materials that are relevant to the geographical and social conditions of a region. In this literature review, several main relevant concepts will be discussed, namely STEM learning, characteristics of maritime areas, and management principles in textbook development.

1. STEM-Based Learning in Middle School Science Education

STEM is an educational approach that integrates four major disciplines: Science, Technology, Engineering, and Mathematics. The aim of STEM-based education is to prepare students to face the challenges of the 21st century by developing the critical, creative and problem solving skills needed in various fields. According to Beers (2011), STEM learning prioritizes the connection between theory and practice by emphasizing the application of scientific concepts in real-world contexts. This not only makes learning more meaningful, but also encourages students to understand how science, technology and engineering are interrelated and applied in everyday life. STEM-based learning can improve students' skills in innovating, developing real projects, and solving complex problems that are often faced in society (Sanders, 2009). In the context of science education, STEM integration is important because the science taught must be relevant to students' daily lives, including the challenges that exist in the environment around them. Thus, the application of STEM in junior high school science textbooks must pay attention to students' social and geographical context, such as the characteristics of maritime areas which have great potential in the marine and fisheries sector.

Moore, Bryan et al (2021) emphasize that integrated STEM learning is not intended to add to an already complete curriculum, but to perfect the existing curriculum and find synergies between scientific disciplines so that students can understand the interdependence

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between science, technology, engineering and mathematics – for example, when they develop an understanding of and learn to explain natural phenomena or design and propose solutions to local, national, or global problems.

2. Characteristics of Maritime Regions in the Education Context

Indonesia's maritime region, which consists of thousands of islands and has the longest coastline in the world, has very diverse natural wealth, from marine resources to potential coastal ecosystems. An educational approach that prioritizes local context is essential to help students understand the relevance of science to their everyday lives. As stated by Nurtjahyo (2017), the characteristics of maritime areas must be taken into account in every development of teaching materials. Indonesia's maritime region has its own challenges in managing natural resources, maintaining marine ecosystems, and adapting to climate change. Therefore, the development of STEM-based science textbooks must focus on issues relevant to the maritime world, such as sustainable use of marine resources, fisheries technology, coastal ecosystem conservation, and understanding climate change which has an impact on marine life.

According to research by Astuti & Prasetyo (2020), implementing local context-based learning in maritime areas can increase students' motivation to learn science, because the teaching material becomes closer to their daily lives. This also supports the development of skills relevant to the needs of local communities, such as skills in the maritime and fisheries fields.

3.Textbook Development Management

Management of developing STEM-based science textbooks that are appropriate to the maritime context requires a systematic approach and involves various parties, from curriculum developers, material writers, to teachers and the local community. In this context, management of textbook development must include planning, collecting relevant teaching materials, developing contextual content, as well as testing and evaluating the implementation of teaching materials. According to Suherman (2013), textbook development management must integrate the principles of diversity, inclusiveness and relevance. The textbooks developed must be able to cover the various needs of students, taking into account differences in social, economic and geographical backgrounds. Apart from that, textbooks must be relevant to the demands of the latest technological and scientific developments in the STEM field, and be able to have a positive impact on developing students' skills in facing challenges in the real world.

Developing STEM-based junior high school science textbooks that are appropriate to the maritime context also requires collaboration between various stakeholders, such as education

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experts, marine experts, and local communities. This is important so that teaching material is not only theory-based, but also applicable and can provide solutions to problems faced by the maritime community.

4. Principles in Developing STEM-Based Middle School Science Textbooks

In developing STEM-based junior high school science textbooks that are appropriate to the maritime context, several important principles need to be considered. First, textbooks must be contextual, that is, able to connect theory with real situations in maritime areas, such as management of marine and coastal natural resources, as well as understanding marine ecosystems that are vulnerable to climate change. Second, textbooks must be interdisciplinary, integrating various scientific disciplines relevant to maritime themes, for example marine physics, marine biology and fisheries technology. Third, textbooks must be innovative and use approaches that facilitate students to collaborate, experiment and solve problems practically. This is in line with the aim of STEM education to develop critical and creative thinking skills. Finally, textbooks must be oriented towards sustainability, that is, not only provide theoretical understanding, but also teach students about the importance of maintaining the balance of marine ecosystems and implementing the principles of sustainable development.

5. Challenges in Developing STEM-Based Textbooks in the Maritime Region

The main challenge in developing STEM-based junior high school science textbooks in maritime areas is limited resources and access to material that is relevant to local conditions. In addition, developing contextual textbooks requires the involvement of many parties, including marine experts and coastal communities, who may have limitations in terms of time, funds and facilities. Apart from that, the application of technology in learning also requires adequate infrastructure support, especially in coastal areas which often receive little attention.

Management of STEM-based Middle School Science Textbook Development in accordance with the Maritime Context

Management in developing STEM-based junior high school science textbooks that are appropriate to the context of maritime areas is an important step in creating learning materials that are relevant, effective, and can increase students' understanding of scientific concepts that are directly related to natural and social conditions in coastal areas. This management process not only includes planning and developing teaching materials, but also involves organizing resources, collaboration between stakeholders, and evaluation to ensure the quality and sustainability of the textbooks being developed.

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1. Textbook Development Planning

Planning is a very crucial initial stage in managing the development of STEM-based junior high school science textbooks. At this stage, it is necessary to carry out an in-depth analysis of the need for teaching materials that are relevant to the maritime context. Some things that need to be considered in planning include:

- Educational Needs Analysis: Identify science topics that are in accordance with the national curriculum and relevant to conditions in maritime areas, such as fisheries technology, coastal ecosystems, sustainability of marine natural resources, and the impact of climate change on marine and coastal life. These topics will form the basis for developing teaching materials that are not only STEM-based, but also local context-based.
- Learning Objectives: Formulate clear learning objectives, namely to develop students' critical thinking, creative and problem-solving skills in the context of problems that exist in the maritime area. This goal must be measurable and closely related to the basic competencies in the junior high school science curriculum.
- STEM-Based Learning Design: Designing a learning approach that integrates science, technology, engineering and mathematics concepts in the context of real maritime problems. Textbooks should encourage students to connect theory with practice through problem-based projects that focus on maritime issues.

2. Organizing Resources

Organizing resources in developing STEM-based junior high school science textbooks requires the involvement of various parties who have competence in the fields of education and maritime affairs. Several steps that must be taken in organizing resources include:

- Teaching Material Development Team: This team must consist of various experts, both in the education sector (especially textbook development and science learning), as well as in the marine and maritime sector, such as marine ecologists, fisheries technicians, and climate change experts. This collaboration is important to ensure that the textbooks developed are not only in accordance with STEM principles, but also include appropriate knowledge about the maritime context.
- Natural Resources and Infrastructure: Developing textbooks based on maritime context requires accurate data and information about marine and coastal natural resources. In addition, infrastructure such as science laboratories, access to learning technology, and facilities for practical field activities must be available to support the implementation of the teaching materials that will be developed.

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- Human Resources: Apart from the development team, junior high school science teachers must also be involved in the textbook development process, both in testing teaching materials and in providing feedback regarding learning effectiveness. Teachers who have experience in coastal or maritime areas have valuable insight into the challenges and needs of students in those areas.

3. Textbook Content Development

At the content development stage, teaching materials must be designed to integrate STEM principles with the local context of the maritime region. Content development includes several steps, including:

- Preparation of Modules and Topics: Textbooks must be arranged taking into account a logical learning sequence that is easy for students to understand. Each module should cover topics relevant to the student's maritime life, for example: "The Role of Technology in Marine Resource Management," "Coral Reef Conservation: Challenges and Solutions," or "The Impact of Climate Change on Marine Ecosystems." Each topic must be linked to applicable aspects of technology, engineering and mathematics.
- Interactive Learning Methods: Textbooks must present material in an approach that encourages students to be actively involved. For example, through science experiments, field activities, case studies, or problem-based projects that invite students to solve real problems in their coastal areas. This approach will help students not only understand science theory, but also develop practical skills in dealing with maritime issues.
- Integration of Learning Media: The use of technology and interactive learning media also needs to be considered. STEM-based textbooks should be equipped with various digital learning resources, such as videos, animations, simulations and software that help students understand difficult concepts in science through interesting and easy-to-understand visualizations.

4. Collaboration and Testing of Teaching Materials

After the textbook content has been developed, the next stage is to carry out trials to identify the strengths and weaknesses of the teaching material that has been prepared. This trial can be carried out through:

- Piloting in Maritime Schools: Testing textbooks in several schools located in coastal and maritime areas to see how students and teachers respond to the teaching materials. Feedback from students and teachers is very important to evaluate whether teaching materials can

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accommodate their needs and whether STEM-based learning can be implemented effectively.

- Evaluation and Revision: Based on the results of the trial, evaluation is carried out to improve the teaching material. This includes improving the structure of the material, conformity with the curriculum, readability, and completeness of learning tools and media. This revision is important to improve the quality and effectiveness of textbooks before they are widely published.

5. Implementation and Monitoring

Implementation of textbooks in junior high schools in maritime areas must be supported by ongoing monitoring. This monitoring aims to ensure that teaching materials are implemented well and have a positive impact on student learning. Some steps that must be taken include:

- Teacher Training: Providing training to junior high school science teachers so that they can implement textbooks correctly. This training also includes an understanding of the STEM approach in science learning, as well as techniques to facilitate students in problem-based projects relevant to maritime affairs.
- Learning Monitoring: Conduct regular monitoring to ensure that learning goes according to plan. This includes evaluating student engagement, understanding of concepts, and their ability to apply STEM knowledge in the context of maritime issues.
- Feedback from Stakeholders: Collect feedback from students, teachers and the local community to evaluate whether the textbook has provided maximum benefits and whether there are aspects that need to be improved for the next edition.

6. Evaluation and Continuous Development

Evaluation of the use of textbooks must be carried out periodically to identify strengths and weaknesses. This evaluation process must involve all stakeholders, including teachers, students, parents, as well as marine and educational experts. Based on the evaluation, teaching materials can be updated and developed further, so that this textbook remains relevant and up-to-date with developments in science and technology, as well as the needs of the maritime community.

- Teacher Competence in Developing STEM-Based Middle School Science Textbooks According to the Maritime Context

Teacher competency plays an important role in the successful implementation of STEM-based junior high school science textbooks at the junior high school level, especially those adapted to the maritime context. Teacher competency does not only include the ability to teach in the pedagogical aspect, but also the ability to integrate an interdisciplinary STEM approach into science learning, as

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well as the ability to relate teaching material to local contexts that are relevant to students' geographic and social conditions, especially in maritime areas. The importance of teacher competence in the process of developing and implementing STEM-based textbooks can be seen from several key aspects, which include mastery of material, pedagogical skills, ability to use technology, and the ability to develop contextual curriculum and teaching materials.

1. Mastery of STEM Materials and Knowledge

Middle school science teachers who will implement STEM-based textbooks must have in-depth mastery of the concepts of science, technology, engineering and mathematics. This is very important so that teachers can explain the material clearly, connect various scientific disciplines in learning, and provide students with a deep understanding of the relationship between theory and practical applications in everyday life. Apart from that, in the context of maritime areas, teachers also need to have sufficient knowledge about marine ecosystems, coastal natural resources, and issues related to marine and fisheries management. This knowledge will help teachers relate science theory to real problems faced by maritime communities, such as climate change, marine pollution, or the sustainability of natural resources.

2. Pedagogical Skills and Context-Based Learning

Pedagogical abilities are basic competencies that every teacher must have to deliver teaching material effectively. In the context of STEM-based textbooks that are adapted to maritime areas, teachers need to master various learning approaches that can facilitate students to learn actively and contextually. One very important approach is problem-based learning (PBL), which emphasizes solving real problems that are relevant to students' lives. In STEM-based learning, teachers must be able to design assignments and projects that encourage students to think critically, collaborate, and find solutions to problems that exist in the maritime area, such as how to utilize technology to maintain the sustainability of marine resources or ways to reduce pollution on the coast.

Apart from that, teachers also need to master interactive learning strategies that integrate experiments, discussions and field activities. Field activities are very important in STEM-based learning, especially in maritime areas, because they give students the opportunity to directly observe the natural conditions and ecosystems they study in class. Teachers must be able to facilitate these activities well, such as arranging activities involving field observations, sampling, or coral reef conservation projects that combine theory and practice.

3.Ability to Use Technology and Learning Media

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The use of technology in STEM-based learning is very necessary to enrich students' learning experiences. Teachers who are competent in the development and use of digital learning media, such as learning videos, computer simulations, or software for virtual experiments, will be very helpful in delivering complex and abstract teaching material. In the context of maritime areas, technology is also very relevant, especially in topics related to marine technology, such as monitoring sea water quality, geographic information systems (GIS) for mapping coastal areas, or the use of sensors to monitor marine life. Teachers who can utilize this technology effectively will be able to provide more interesting and applicable learning experiences for students.

4. Ability to Develop Curriculum and Contextual Teaching Materials

Teachers who are competent in developing curriculum and teaching materials also have an important role in managing the development of STEM-based science textbooks that are appropriate to the maritime context. The textbooks that are developed must be able to connect theory with reality in the field, so that students can more easily understand the concepts being taught and feel more interested in learning. For this reason, teachers need to have the skills to adapt teaching materials to local contexts, for example by adding topics that are directly related to students' lives, such as sustainable fisheries management, marine conservation, or the use of technology in the marine sector. Apart from that, teachers must also be able to organize activities or projects that encourage students to think critically about the issues around them, and look for solutions based on the knowledge they are learning.

5. Collaboration and Communication Ability with Stakeholders

Management: The development of STEM-based junior high school science textbooks that are appropriate to the maritime context cannot be done by just one party. It requires collaboration between various stakeholders, including education experts, marine experts and local communities. Therefore, teachers need to have the ability to collaborate with various parties, such as other teaching staff, marine experts, or research institutions working in the maritime sector, to create teaching materials that are more accurate and applicable. Good communication skills are also needed by teachers to convey complex teaching material to students in a way that is easy to understand. On the other hand, teachers also need to communicate with parents and local communities to increase their awareness of the importance of STEM-based education that is relevant to maritime regional conditions, as well as to get support in implementing field projects or practicum activities that involve the surrounding environment.

CONCLUSION

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Management of science textbook development for junior high school students involves a series of systematic steps designed to ensure the quality and relevance of textbooks in supporting the learning process. Conclusions that can be drawn in developing textbooks require comprehensive planning, including identifying student needs, curriculum analysis, and determining learning objectives. Effective management at this stage ensures that textbooks meet national education standards and student needs. Team management involving material experts, designers and educators is very important to produce quality textbooks. Collaboration between team members must be managed well to ensure alignment between content, visual design, and learning strategy.

REFERENCES

Afifah, Anis. (2021). Improving Students' Science Process Skills in the Science Subject Concept of Pressure in Liquids Through a STEM (Science Technology Engineering Mathematics) Approach in Class VIII SMPN 4 Bogor City. Journal of Primary School Teacher Education and Teaching (JPPGuseda). 04(1) Pg. 75 -79.

Agustina, R., Huda, I., & Nurmaliah, C. (2020). Implementation of STEM Learning on Plant and Animal Reproductive Systems Material on the Scientific Thinking Ability of Middle School Students. Indonesian Journal of Science Education, 8(2), Article 2. https://doi.org/10.24815/jpsi.v8i2.16913.

Department of Education. (2020). A comprehensive approach to STEM education. Washington, DC

Destrini, H., Nirwana, & Sakti, I. (2018). Application of the Guided Discovery Learning Model to Improve Students' Learning Outcomes and Science Process Skills. Journal of Coil Physics, 1(1), 13–21.

Firdaus, M., Rahayu, P., & Nuraeni, F. (2023). The Influence of the Science, Technology, Engineering, and Mathematics (STEM) Approach on Elementary School Students' Science Process Skills. Fondatia, 7(3), 720-730.

Gazali, A., Hidayat, A., & Yuliati, L. (2015). Effectiveness of the 5E Learning Cycle Model on Students' Science Process Skills and Critical Thinking Abilities. Journal of Science Education, 3(1), 10-16.

Hermansyah, H. (2020). STEM-Based Science Learning Helps ICT in Improving 21st Century Skills. Scientific Journal of Educational Professionals, 5(2), 129-132.

E-ISBN :
E-ISSN : 3047-6399
Volume 2 : 212-224

Kusumayuni, P. N., Suarni, N. K, & Margunayasa, I. G. (2023). STEAM-Based Discovery Learning Model: Impact on Students' Science Learning Outcomes and Science Process Skills. Scientific Journal of Teacher Professional Education, 6(1), 186–195.

Tipmontiane, K., & Williams, P. J. (2022). ASEAN Journal of Science and The Integration of the Engineering Design Process in Biology-related STEM Activity: A Review of Thai Secondary Education. 1(1), 1–10.

Lo, C. K. (2021). Design Principles for Effective Teacher Professional Development in Integrated STEM Education: A Systematic Review. Educational Technology & Society, 24(4), 136–152

Moore, T. J., Bryan, L. A., Johnson, C. C., & Roehrig, G. H. (2021). Integrated STEM education. In STEM Road Map 2.0 (pp. 25-42). Routledge.

Wastiti, L., & Sulur, S. (2020). The influence of STEM-thinking maps in the guided inquiry learning model on class XI students' critical thinking abilities on temperature and heat material. J. Educator Literacy. Phys, 4(2), 110–115. https://doi.org/http://dx.doi.org/10.17977/um058v4i2p110-115

Nugroho, Oktian Fajar, Anna Permanasari, Harry Firman. (2019). Stem-Based Learning Programs for Science Learning: Literature Review, With References in Indonesia. Education Journal. 3(2)

Organization for Economic Co-operation and Development. (2018). The future of education and skills: Education 2030. OECD Publishing U.S.