



Research-Based Teaching Materials As Innovation In Chemistry Learning

Elvy Rahmi Mawarnis^{1*}, Liszulfah Roza², Sri Maiyena³, Mohd Yusri Abd. Rahman⁴

¹Department of Chemistry Education, Faculty of Tarbiyah, Universitas Islam Negeri Mahmud Yunus, Batusangkar, Indonesia

²Research Center for Advanced Materials, National Research and Innovation Agency (BRIN), Tangerang Selatan, Indonesia

³Department of Physics Education, Faculty of Tarbiyah, Universitas Islam Negeri Mahmud Yunus, Batusangkar, Indonesia

⁴Institute of Microengineering and Nanoelectronics, Universiti Kebangsaan Malaysia, Selangor, Malaysia

Received: March 7, 2023

Revised: August 19, 2023

Accepted: September 25, 2023

Published: September 30, 2023

Corresponding Author:

Elvy Rahmi Mawarnis

elvyrhimmawarnis@gmail.com

DOI: [10.29303/jppipa.v9i9.3370](https://doi.org/10.29303/jppipa.v9i9.3370)

© 2023 The Authors. This open access article is distributed under a (CC-BY License)



Abstract: Most of the teaching materials used during learning are not research-based. To address this issue, this paper deals with a literature review regarding the intent and interpretation of research-based learning. The data were obtained from library sources such as papers and books. The data analysis technique is content analysis, where the content of the collected data is read, recorded, and analyzed in order to obtain a concept. The use of teaching materials that contain research-based learning methods in chemistry learning is considered suitable. The findings of the concept are discussed in depth.

Keywords: Chemistry; Research-based learning; Teaching materials

Introduction

Learning process, which is generally carried out at various levels of education, most often takes the form of conventional learning, mostly focused on educators rather than students. Data directly transferring to students is accordingly performed with the stipulated materials presented through learning by which a complete set of facts and principles can be taught in a coherent manner to students, but overall they receive the prepared materials and are passive in terms of finding facts (Khozaei et al., 2022). Conventional learning generally makes students passive, less able to construct knowledge, so they cannot increase their activeness, critical thinking skills, and students' insight (Indrilla & Ciptaningrum, 2018). For this reason, educators should make innovations so that learning can run well. One of the actions that can be applied to practice research-based learning (Brew & Saunders, 2020).

Research-based learning is an effort carried out to seek, develop, and test the truth of a knowledge and

conclude the obtained findings (Bergmark, 2022). In research-based learning, students are guided to solve problems based on research that is relevant to the material being studied. Research-based learning can be done with a variety of learning models. For science subjects such as Chemistry, research-based learning can be done in the form of practical activities. The implementation of practicum activities is intended so that students have insight, abilities, and a scientific spirit (Carnell & Fung, 2017).

To implement research-based learning, one way that educators can do is to use research-based teaching materials. The use of teaching materials is intended to make the learning process more focused. Teaching materials that have good quality can increase students cognitive skills (Bonk & King, 2012; Nurdyansyah, 2018). The intended teaching materials must be able to focus on maximizing students activities in learning so that they can draw conclusions from learning outcomes in accordance with the obtained data. In research-based teaching materials, various learning models can be

How to Cite:

Mawarnis, E.R., Roza, L., Maiyena, S., & Rahman, M.Y.A. (2023). Research-Based Teaching Materials As Innovation In Chemistry Learning. *Jurnal Penelitian Pendidikan IPA*, 9(9), 634–643. <https://doi.org/10.29303/jppipa.v9i9.3370>

applied in accordance with research-based learning, namely, inquiry learning, problem based learning, contextual learning, active learning, peer instruction, and cooperative learning (Haryati, 2017; Usmeldi et al., 2017). In addition, research-based teaching materials can also contain various research results that are suitable for learning. Based on research conducted by Peniati, it is known that teaching materials in the form of modules made by incorporating various research results are effectively used for the learning process (Peniati, 2012).

However, when viewed from the point of view of the use of teaching materials, there are many educators use textbooks with a relatively slower pace of scientific framework than scientific journals (Cook, 2006). This makes students less aware of the latest research that may be relevant to their learning. Most of the teaching materials used during learning are not research-based. To address this issue, this paper highlights a literature review regarding the intent and interpretation of research-based learning. After understanding research-based learning well, the advantages of various research-based teaching materials and their relation to Chemistry learning are explained.

Method

This research is a qualitative research that utilizes library research methods. This research does not go directly to the field to collect data and meet with informants because the data will be obtained from library sources such as books and papers. The data analysis technique is content analysis, where the content of the collected data were read, recorded, and analyzed in order to obtain a concept.

Result and Discussion

Research-based Learning

Research is seen as a process of in-depth investigation or investigation to obtain the latest knowledge that is suitable for use when learning is obtained from a series of steps by researchers in the scientific area (Hoepfl, 1997; Wong & Hodson, 2009). The incorporation of research in the learning process using student-centered learning approaches is referred to as research-based learning. Research in learning is defined as an orderly, coherent, scientific, and multifaceted stage in finding an answer to a particular question (Beatty & Gerace, 2009). In this study, a "learning by doing" approach was used. Research-based learning wants students to be able to find, explore knowledge to solve problems that occur, then verify the validity of that knowledge (Beatty & Gerace, 2009; Kirschner et al., 2006).

According to Harsono, research-based learning is based on constructivism theory which has four objectives, namely: 1) learning creates student understanding, 2) learning by growing prior knowledge, 3) learning includes the process of social relationships among fellow students, educators, and students by educators, and 4) substantial learning gained with experience from students (Kirschner et al., 2006).

With research-based learning, there are opportunities to develop learning methods, including: 1) updating learning materials (curriculum enrichment) by incorporating research results, 2) students actively participating in research, 3) learning by using tools-research tools, and 4) extensive development of research positions (students explore the steps and results of research to understand matters related to synthesis) (Aronson & Laughter, 2016; Minner et al., 2010). Research-based learning incorporates research into learning. This means that students can actively solve problems using the theories presented by educators and correlate with their daily learning process, thus students become more critical in their thinking (Ülger, 2016). With the application of research-based learning, it is hoped that the character formed in students is the soul of a scientist. This attitude is characterized by a high curiosity, able to solve every problem, with an attitude of thinking systematically, objectively, and having a strong rationale (Slameto, 2015).

Research-based learning is able to renew the essence of education from the process of remembering the main points of learning into inquiry-based learning, after which students try to explore and solve problems (Juntunen & Aksela, 2013). From this explanation, it can be interpreted that the professionalism of students increases with the implementation of research-based learning (Clark et al., 2009; Hepworth & Walton, 2009). Research-based learning makes students not only understand the concepts of the material being studied, but also can make students get a higher level of learning, up to innovative ability. This learning way provides an opportunity for students to examine, include and connect research to their learning activities (Edelson, 2001). Furthermore, research-based learning should be applied in many subjects, such as Mathematics, Science, by linking research and teaching (Schapper & Mayson, 2010).

Research-based learning is relied on to create personality in students so that they have a scientist character. Research activities are connected with the knowledge and character of students in everyday life to develop students' abilities. The followings are the strategies for integrating research and learning empirically according to Gryffith University, namely; 1) multiply learning tools with the results of educators'

research, 2) take advantage of the latest research results and scan history, 3) increase learning activities with the latest research themes, 4) use research method materials during learning, 5) increase learning activities with research activities at a small level, 6) conduct learning that includes students in activities, 7) conduct learning by motivating students to be sensitive to their surroundings, and 8) carry out learning referring to the points that a researcher must have (Prafitasari & Sulistyarsi, 2020; Slameto, 2015).

Learning model of research-based learning

The models of research-based learning (Rohim & Sucianto, 2019; Sucianto et al., 2019) are as follows:

1. Inquiry Learning

The origin of the word "inquire" brings the meaning of asking for information. Students are prepared to be active both physically and spiritually. Inquiry-based learning involve students directly in real life by carrying out their own investigations to find objectives of the material being studied. (Slameto, 2015). In inquiry learning, the material taught by educators is not immediately accepted by students, but students are pursued in various ways so that they gain various kinds of knowledge to "find for themselves" the concepts that are delivered by educators (Naezak et al., 2021).

Based on the explanation by Carin and Sund, it is known that there are various types of inquiry learning models, namely guided inductive inquiry, unguided inductive inquiry, deductive inquiry, and problem solving. According to these models, the right inquiry to be applied in secondary schools is usually guided inductive inquiry. This is because students actively participate in learning about a phenomenon by collecting and processing data to reach a conclusion. In guided inductive inquiry, the teacher no longer acts as a provider of information, but the teacher makes lesson plans or experimental steps. Students conduct experiments or investigations to prove concepts that have been taught by the teacher (Wallace & Kang, 2004; Windschitl, 2003).

There are five steps in inquiry learning, namely: 1) Orientation, which is the initial step in starting learning, 2) Exploration, is the step where students begin to carry out investigations, 3) Concept formation, is a step where students can assemble concepts from investigations, 4) Application, at this step there are exercises in the form of questions that are useful to strengthen understanding concepts that were previously obtained, 5) Closing, is the last step in the form of getting conclusions of the teaching material by students (Andrews, 1984; Chen, 2022; Pollock & Harper, 2022).

Basically, the purpose of learning with inquiry is to help students to elaborate questions, explore answers or

solutions as an outlet for curiosity and to support certain theories. In addition, inquiry learning aims to improve thinking skill and increase critical thinking.

The inquiry model can create more fun learning activities so that it can have an impact on mastery of the concepts. This model is essential to be applied as a way to maximize the quality of education. The use of this model during the learning process offers opportunities for students to work together in group to solve problems. The division of students into groups enhances cooperative relationships between students which are very important and mutually supportive for the scientific development or cognitive aspects of students. The use of the inquiry learning model guides students to familiarize themselves to be active and communicate well with fellow group members. All members must participate in solving the problems. The group's success in completing tasks is supported by the collaboration of members, so that group members are united with each other (Kuisma, 2022; Pollock & Harper, 2022).

2. Problem Based Learning

Problem based learning (PBL) is a learning model based on solving problems. In this learning model, students acquire a concept and also solve problems, because learning begins with some problems (Firmadani, 2017; Fitria et al., 2022; Priyanto & Permatasari, 2022). The problems are usually real-world problems that seem unstructured. If it's a simulated problem, it should be as authentic as possible. The problem requires multiple perspectives. The use of cross-disciplinary knowledge is a key feature in many PBL curricula. After all, PBL encourages problem solving by leveraging knowledge of a wide range of subjects and topics. The problem challenges students' current knowledge, attitudes, and competencies, thus requiring identification of learning needs and new areas of learning. This model has several learning steps, namely: 1) Orientation, it is a step where students know the problem. The teacher explains the learning objectives, describes the equipment needed and triggers the enthusiasm of the students to be able to solve identified problems, 2) Organizing students, in this step, the teacher supports students in interpreting and organizing learning tasks related to identified problems, 3) Guiding investigations both individually and in groups. Educators invite students to collect relevant information, conduct experiments to gain knowledge and solve problems, 4) Developing and presenting work. Educators guide students in designing and completing relevant works such as preparing reports, videos and models and helps them with various assignments with their friends and 5) Analyzing and evaluating problem solving procedures. Educators guide students to

evaluate the procedures that have been carried out in solving problem.

Problem based learning is an effective model used in learning. Problem based learning maximizes students to get the data and designs their insights from basic to complex insights. The hallmark of problem-based learning is that it is student-centered, designed according to the original problem that makes students to form abundant insights about contextual theory with a series of constructive questions. Learning process that involves students to find solutions to real life problems can increase enthusiasm and curiosity (Malmia et al., 2019).

3. Contextual Learning

Contextual learning (CL) is learning model of content presentation using various active learning techniques to make it easy for students to connect something that has become their insight with what they are expected to learn, and to foster the latest insights from the learning process (Hudson & Whisler, 2007). It is easy for educators to connect the subject matter with the environmental conditions and motivates students to form interactions between the insights they have and their implementation in their daily environment (Dewi & Primayana, 2019; Firmadani, 2017; Sulfemi, 2019).

Contextual learning has the aim of helping students to well understand the concept of learning material and correlate it with situations in the daily environment such as personal, social, and cultural situations, which can make students have intense and flexible/competence (Humana & Rahmat, 2022).

Contextual learning applies seven components to make learning activities effective, namely: 1) constructivism, it is the philosophical thinking of contextual learning, 2) question component, it is main component of learning based on a contextual approach, 3) Inquiry, it is core of learning activities using a contextual learning approach. The competencies that students gain are not only from the process of memorizing a set of theories, but are also from their own discoveries, 4) learning community expresses teaching and learning outcomes as a result of compromise on certain parties such as working in groups with seniors, students who already know tell those who don't know and so on and collaborating with the community (rephrase this sentence), 5) modeling, in learning there needs to be a model that can be imitated by students. It is a great opportunity for educators to demonstrate examples of learning before students do the task. When the teacher is able to do something, the student will think that they can do it too, 6) reflection is a form of thinking about something that has just been learned, thinking about what has been studied in the past and 7) authentic assessment, it is a process of gathering

information, which is able to issue a picture of student learning activities (Hendawati et al., 2019; Selvianiresa & Prabawanto, 2017).

The application of contextual learning makes students are motivated to correlate the insights they gain with their application in their daily environment when they act as children, Indonesian citizens, and workers. It can also help them participate actively during learning (Firmadani, 2017). Contextual learning makes students to be more independent because students have been able to draw their own conclusions and obtain concepts during the learning process (Latipah & Afriansyah, 2018).

4. Active Learning

Active learning is generally defined as activities carried out by students to gain knowledge. Students earnestly use their minds, either to get the core idea of the subject matter, solve problems, or apply knowledge gained during learning. The activities are varied but require higher order of thinking (Brame, 2016; Maksum & Hani, 2018).

Active learning is one of the preferences to improve the quality of learning to be more effective, which is desired to be able to maximize the quality of learning at various levels of education, because in active learning, there are several parameters that are able to develop the competence of educators and improve learning, interests and activities of students while learning. The intended parameters include: (1) increasing student participation during learning activities, (2) providing work opportunities for each student, (3) creating a creative spirit for students, 4) realizing interaction during the learning process to be effective, and (5) creating a fun learning atmosphere. Active learning makes students the center of learning and has the opportunity to trigger the creation of positive activities in the learning process. Students are guided to learn actively by touching, feeling, and seeing directly and experiencing it themselves, so that learning is more meaningful and understood by students (Maksum & Hani, 2018).

Active learning in principle moves to sharpen and accelerate the stimulant and enthusiasm of students to learn, so that the learning process is fun and far from bored. By applying active learning to students, it can improve their memory, so that the objectives of learning can be achieved efficiently and effectively (Kovarik et al., 2022; Zein, Budianti, & Gea, 2022).

5. Peer Instruction

Students are given the opportunity to find common sense in solving various problems regarding the teaching material presented by the educator after being discussed with their peers. Not only that, when implementing peer instruction, students are expected to

be able to maximize their understanding of the material by exchanging ideas and consulting with peer instruction is a learning method that organizes a number of students who are given the responsibility to help certain students who face difficulties while learning. The help provided by peer students is basically able to help students and produce better results (Fagen et al., 2002).

The steps for implementing the peer instruction method according to Tan Tee Hwa are: 1) Develop learning tools that must be distributed to students, 2) Analyze learning subjects that must be explained after considering what students need this year; (peer instruction method is usually for reviewing learning at the time of semester closing) 3) Educators assign students to groups, 4) Each group has one subject with a certain worksheet to discuss together, 5) Educators supervise and guide each group to verify that there are basic skills that need to be learned: such as interaction between fellow group members and answering questions in the worksheet, 6) perfecting learning by using pictures, writing, sound, and video, 7) assessment is taken half from learning activities and worksheet and the other half the value from the presentation display when appearing in front, 8) arrange time for each group to perform and present, 9) the teacher guides each group of students to be trained in conveying the results of their discussion in front of class and 10) preparing suggestion sheets, criticisms, and messages for the appearance of students with the intention of being able to make them better in the future.

Peer instruction has the potential to develop student activity during learning activities (Simon et al., 2013). Students' responses to peer instruction are generally positive; students reported that the technique helped them learning the subject matter and the direct feedback provided was invaluable (Knight & Brame, 2018). Utilization of peer instruction learning has a positive impact on students' thinking skills (Velez et al., 2011).

6. Cooperative Learning

Cooperative learning is based on a learning model that triggers students to interact in small groups and help each other during learning. Cooperative learning is a group of teaching strategies used by educators so that students help each other during the learning process. There are four kinds of cooperative learning that were told by Arends, namely; 1) Student Teams Achievement Division (STAD), 2) Group Investigation, (3) Jigsaw, and 4) Structural Approach consisting of think-pair-share (TPS), and numbered-head-together (NHT).

The use of cooperative learning models during the teaching and learning process is aimed at sharpening the abilities and insights of each group member with the intention that students can complete and understand the

teaching material by group learning rather than individual learning. Cooperative learning model that can trigger the enthusiasm of students to have critical thinking as well as innovative and creative (Harits et al., 2019). Results should be clear and concise. The discussion should explore the significance of the results of the work, not repeat them. A combined Results and Discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

Research-based teaching materials

Teaching material is one of the various components included in learning tools that educators use during learning activities to direct students to learn. The design of teaching materials must be adjusted to clear criteria and specifications (Danielson, 2007; Davis & Krajcik, 2005). The developed teaching materials are very diverse, synchronized with the characteristics of the learning materials. The teaching materials can be in the form of textbooks, student worksheets, modules, booklets, or brochures. Good teaching materials are used as a preference for learning resources other than textbooks which are often difficult to have (Benkler, 2005). Making teaching materials that fit the interests and character of each student makes learning effective and conducive (Abdullah et al., 2019). Teaching materials include external factors that influence students' motivation to study hard (Tuan, 2012).

One of the teaching materials that can be developed for learning is research-based teaching materials. Research-based teaching materials are teaching materials in which learning methods are applied, including the implementation of research-based learning. The learning models are inquiry learning, problem based learning, contextual learning, active learning, peer instruction, and cooperative learning. These various models have various advantages when applied to learning. Teaching materials with this model expect students to be able to search, explore (grow insight) to solve existing problems, and then verify the validity of these insights. The implementation of research-based learning on learning tools is very helpful for educators in carrying out their duties. In addition to producing a good impact on educators, it also has a good impact on students to hone critical, creative, logical thinking skills, and problem solving (Seechaliao, 2017).

In research-based teaching materials, there are also research results that are relevant to learning. The development of teaching materials with research results can be used as a strategy in integrating learning and research empirically. In the learning process, research results are used to improve the quality of teaching materials. Educators can present research results as real examples in learning, which are expected to help students understand ideas, concepts, and theories.

Applicative learning resources are obtained from learning in universities through the results of research (Lotulung et al., 2018). Supplements of teaching materials that are equipped with subject matter and pictures of research results are relevant to the daily lives of students, inspiring teachers to compile similar teaching material supplements on other subject matter they teach. Supplements of teaching materials are effective in improving students' pretest-posttest results (Rani, Widiyaningrum, & Anggraito, 2020). Student research knowledge is increased significantly over the course of research-based learning participation (Wessels, Rueß, Gess et al., 2021).

Research-based learning tools are needed because they play an important role in supporting education, especially in Indonesia. The existence of research-based learning tools allows educators to create a quality generation of the nation (Tan, 2016; Towne & Shavelson, 2002). Books that are used as guidelines in the learning process can have a high impact on the achievement of learning objectives, considering that in the teacher's book, starting from learning plan, worksheet assessment and so on. By maximizing, refining, and developing research-based books, it can make a big contribution to efforts to improve the learning process (Crawford et al., 2005; Plomp, 2013).

Research-based teaching materials have various advantages in the learning process. The development of research-based textbooks can seek more contextual learning (Ambrose et al., 2010; Bennett & Holman, 2002). Research results that are used as learning resources and compiled in textbooks can provide real experiences so that learning is more contextual. Modules developed by integrating research results are effectively used in learning (Amaringga et al., 2021). Research-based modules improve the learning process of students because they are compiled based on the results of the author's research where the purpose of the preparation is to improve students' contextual understanding by connecting academic subjects in students' daily lives (Banegas & de Castro, 2019). Learning using research-based booklets has a positive influence on learning outcomes (Makransky & Petersen, 2021).

Research-based teaching materials in Chemistry learning

Chemistry is a science subject that analyzes in depth about matter, in terms of its properties, behavior, the changes it undergoes during reactions with other substances, and the energy that is released or absorbed during these processes (Atkins & De Paula, 2011). The scope of learning Chemistry is not only limited to the use and derivation of formulas, but is also an arrangement of a group of laws, theories, principles, and facts described according to a series of processes to

investigate the answers to what, why, and how-based questions.

In Chemistry learning, there are various ways to improve the quality of the learning process. One way that can be implemented is by using teaching materials. The use of appropriate teaching materials can make learning more effective. One of the teaching materials that can be used in learning chemistry is research-based teaching materials. The integration of research-based learning in chemistry learning has an impact on changes in students' knowledge (Rohrbach-Lochner & Marohn, 2018). Research-based teaching materials in Chemistry learning contain research-based learning methods. In addition, in the teaching materials there are research results that are relevant to learning Chemistry.

One of the research-based teaching materials in Chemistry learning is the research-based Basic Chemistry II textbook by Elvy Rahmi Mawarnis. In the textbook, there is a research-based learning method. It can be seen that the application of research-based learning methods can improve the quality of the learning process. This is because these methods have various advantages that optimize the learning process. Each chapter of the material in the book contains research results that are relevant to the learning material. One of the research results in the book is about AgPt nanofern catalysts (Mawarnis, 2021). In this research, it is known that the AgPt nanofern catalyst has been successfully synthesized using the liquid phase deposition method. The catalyst has succeeded in accelerating the rate of the degradation reaction of the pollutant methyl orange which is very harmful to the environment (Umar et al., 2014). The research results in the textbook are in accordance with the Chemistry learning material, namely, the rate of reaction.

Research results on teaching materials can provide insight to students as they become aware of the latest research developments in the field of Chemistry. Several benefits can be identified if the results of scientific journal research are used in the learning process. For students, in addition to getting quality reading, they are able to follow scientific developments regarding the subject being studied (DeBoer, 2000). Utilization of research-based teaching materials is successful when learning Chemistry can increase students' knowledge.

Conclusion

Research-based learning is a student-centered learning that combines research in the learning process. There are several models of research-based learning, namely, inquiry learning, problem based learning, contextual learning, active learning, peer instruction, and cooperative learning. To apply research-based

learning, one way that educators can do is to use research-based teaching materials. Research-based teaching materials contain research-based learning methods and research results that are relevant to learning. The use of teaching materials that contain research-based learning methods in chemistry learning is considered suitable. This is because research-based methods have various advantages that optimize the learning process. In addition, the research results in teaching materials are useful for students in getting quality reading. Students are able to follow scientific developments regarding the subject being studied. Thus, research-based teaching materials can be an innovation in Chemistry learning.

Author Contributions

E.R.M and L.R conduct the Conceptualization, methodology, validation, formal analysis, investigation, resources, data curation, writing—original draft preparation, writing—review and editing. S.M and M.Y.R conduct visualization, supervision, project administration.

Funding

The authors would like to acknowledge Universitas Mahmud Yunus Batusangkar, Indonesia for funding this work under research grants DIPA-025.04.2.424069/2020

Conflicts of Interest

The authors declare that they have no known competing financial interest or personal relationships that could have appeared to influence the work reported in this paper

References

- Abdullah, I., Hudayana, B., Kutaneegara, P. M., & Indiyanto, A. (2019). Beyond school reach: Character education in three schools in Yogyakarta, Indonesia. *Journal of Educational and Social Research*, 9(3), 145-145. <https://doi.org/10.2478/jesr-2019-0032>
- Amaringga, N. G., Amin, M., & Irawati, M. H. (2021). The effect of problem-based learning module containing research result to improve students' scientific literacy. *Paper presented at the AIP Conference Proceedings*. <https://doi.org/10.1063/5.0043529>
- Ambrose, S. A., Bridges, M. W., DiPietro, M., Lovett, M. C., & Norman, M. K. (2010). *How learning works: Seven research-based principles for smart teaching*: John Wiley & Sons.
- Andrews, J. D. (1984). Discovery and expository learning compared: Their effects on independent and dependent students. *The Journal of Educational Research*, 78(2), 80-89. <https://doi.org/10.1080/00220671.1984.10885578>
- Aronson, B., & Laughter, J. (2016). The theory and practice of culturally relevant education: A synthesis of research across content areas. *Review of Educational Research*, 86(1), 163-206. <https://doi.org/10.3102/0034654315582066>
- Atkins, P., & De Paula, J. (2011). *Physical chemistry for the life sciences*: Oxford University Press, USA.
- Banegas, D. L., & de Castro, L. S. V. (2019). *Action research The Routledge handbook of English language teacher education* (pp. 570-582): Routledge.
- Beatty, I. D., & Gerace, W. J. (2009). Technology-enhanced formative assessment: A research-based pedagogy for teaching science with classroom response technology. *Journal of Science Education and Technology*, 18(2), 146-162. <https://doi.org/10.1007/s10956-008-9140-4>
- Benkler, Y. (2005). *Common Wisdom: Peer Production of Educational Materials*, Center for Open and Sustainable Learning. Retrieved from <http://nrs.harvard.edu/urn-3:HUL.InstRepos:37077901>
- Bennett, J., & Holman, J. (2002). *Context-based approaches to the teaching of chemistry: What are they and what are their effects?* Chemical education: Towards research-based practice (pp. 165-184): Springer.
- Bergmark, U. (2022). The role of action research in teachers' efforts to develop research-based education in Sweden: intentions, outcomes, and prerequisite conditions. *Educational Action Research*, 30(3), 427-444. <https://doi.org/10.1080/09650792.2020.1847155>
- Bonk, C. J., & Cunningham, D. J. (1998). Searching for learner-centered, constructivist, and sociocultural components of collaborative educational learning tools. In C. J. Bonk & K. S. King (Eds.), *Electronic collaborators: Learner-centered technologies for literacy, apprenticeship, and discourse* (pp. 25-50). Lawrence Erlbaum Associates Publishers
- Brame, C. (2016). *Active learning*. Vanderbilt University Center for Teaching. Retrieved from <https://cft.vanderbilt.edu/guides-subpages/active-learning/>. ISBN: 9780470484104
- Brew, A., & Saunders, C. (2020). Making sense of research-based learning in teacher education. *Teaching and Teacher Education*, 87, 102935. <https://doi.org/10.1016/j.tate.2019.102935>
- Carnell, B., & Fung, D. (2017). *Developing the higher education curriculum: Research-based education in practice*: UCL Press.
- Chen, J. (2022). *Cognitive Mapping for Problem-based and Inquiry Learning: Theory, Research, and Assessment*.
- Clark, R. E., Yates, K., Early, S., & Moulton, K. (2009). An analysis of the failure of electronic media and discovery-based learning: Evidence for the

- performance benefits of guided training methods. *Handbook of Improving Performance in the Workplace: Volumes* 1-3, 263-297. <https://doi.org/10.1002/9780470592663.ch8>
- Cook, M. P. (2006). Visual representations in science education: The influence of prior knowledge and cognitive load theory on instructional design principles. *Science education*, 90(6), 1073-1091. <https://doi.org/10.1002/sce.20164>
- Crawford, V. M., Schlager, M., Toyama, Y., Riel, M., & Vahey, P. (2005). *Characterizing adaptive expertise in science teaching. Paper presented at the annual meeting of the American Educational Research Association, Montreal, Quebec, Canada.* https://doi.org/10.1207/s1532690xci2202_1
- Danielson, C. (2007). *Enhancing professional practice: A framework for teaching*: ASCD.
- Davis, E. A., & Krajcik, J. S. (2005). Designing educative curriculum materials to promote teacher learning. *Educational researcher*, 34(3), 3-14. <https://doi.org/10.3102/0013189X034003003>
- DeBoer, G. E. (2000). Scientific literacy: Another look at its historical and contemporary meanings and its relationship to science education reform. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, 37(6), 582-601. [https://doi.org/10.1002/1098-2736\(200008\)37:6%3C582::AID-TEA5%3E3.0.CO;2-L](https://doi.org/10.1002/1098-2736(200008)37:6%3C582::AID-TEA5%3E3.0.CO;2-L)
- Dewi, P. Y. A., & Primayana, K. H. (2019). Effect of learning module with setting contextual teaching and learning to increase the understanding of concepts. *International Journal of Education and Learning*, 1(1), 19-26. <https://doi.org/10.31763/ijelev1i1.26>
- Edelson, D. C. (2001). Learning-for-use: A framework for the design of technology-supported inquiry activities. *Journal of Research in Science teaching*, 38(3), 355-385. [https://doi.org/10.1002/1098-2736\(200103\)38:3%3C355::AID-TEA1010%3E3.0.CO;2-M](https://doi.org/10.1002/1098-2736(200103)38:3%3C355::AID-TEA1010%3E3.0.CO;2-M)
- Fagen, A. P., Crouch, C. H., & Mazur, E. (2002). Peer instruction: Results from a range of classrooms. *The physics teacher*, 40(4), 206-209. <https://doi.org/10.1119/1.1474140>
- Firmadani, F. (2017). Pembelajaran Berbasis Riset Sebagai Inovasi Pembelajaran. *Prosiding TEP & PDs*, 4(14), 262-268.
- Fitria, D., Imran, A., & Ahda, Y. (2022). Studi Literature Model Problem Based Learning. *International Journal Of Humanities Education and Social Sciences (IJHESS)*, 1(6). <https://doi.org/10.55227/ijhess.v1i6.177>
- Harits, M., Sujadi, I., & Slamet, I. (2019). Technological, pedagogical, and content knowledge math teachers: To develop 21st century skills students. Paper presented at the *Journal of physics: Conference series*. <https://doi.org/10.1088/1742-6596/1321/3/032011>
- Haryati, A. S. (2017). The implementation of 21st century learning to improve high level thinking skills through various model. Paper presented at the *International Conference on Education*. <https://doi.org/10.1088/1742-6596/1318/1/012130>
- Hendawati, Y., Pratomo, S., Suhaedah, S., Lestari, N., Ridwan, T., & Majid, N. (2019). Contextual teaching and learning of physics at elementary school. Paper presented at the *Journal of Physics: Conference Series*. <https://doi.org/10.1088/1742-6596/1318/1/012130>
- Hepworth, M., & Walton, G. (2009). *Teaching information literacy for inquiry-based learning*: Elsevier.
- Hoepfl, M. C. (1997). *Choosing qualitative research: A primer for technology education researchers*. Volume 9 Issue 1 (fall 1997). <https://doi.org/10.22089/res.2022.12026.2218>
- Hudson, C. C., & Whisler, V. R. (2007). Contextual teaching and learning for practitioners. *Journal of Systemics, Cybernetics and Informatics*, 6(4), 54-58. ISSN: 1690-4524
- Humana, P., & Rahmat, R. (2022). Contextual Teaching Learning in the Development of a Student's Environmental Care Attitude During the Covid-19 Pandemic. Paper presented at the *Annual Civic Education Conference (ACEC 2021)*. <https://doi.org/10.2991/assehr.k.220108.051>
- Indrilla, N., & Ciptaningrum, D. S. (2018). An approach in teaching writing skills: does it offer a new insight in enhancing students writing ability. *LLT Journal: A Journal on Language and Language Teaching*, 21(2), 124-133. <https://doi.org/10.24071/llt.2018.210201>
- Juntunen, M., & Aksela, M. (2013). Life-cycle analysis and inquiry-based learning in chemistry teaching. *Science Education International*, 24(2), 150-166. ISSN-2077-2327
- Khozaei, S. A., Zare, N. V., Moneghi, H. K., Sadeghi, T., & Taraghdar, M. M. (2022). Effects of quantum-learning and conventional teaching methods on learning achievement, motivation to learn, and retention among nursing students during critical care nursing education. *Smart Learning Environments*, 9(1), 1-11. <https://doi.org/10.1186/s40561-022-00198-7>
- Kirschner, P., Sweller, J., & Clark, R. E. (2006). Why unguided learning does not work: An analysis of

- the failure of discovery learning, problem-based learning, experiential learning and inquiry-based learning. *Educational psychologist*, 41(2), 75-86. <https://doi.org/10.1017/S0140525X01003922>
- Knight, J. K., & Brame, C. J. (2018). Peer instruction. *CBE – Life Sciences Education*, 17(2), fe5. <https://doi.org/10.1187/cbe.18-02-0025>
- Kovarik, M. L., Ott, L. S., Robinson, J. K., & Wenzel, T. J. (2022). Getting Started on Active Learning Active Learning in the Analytical Chemistry Curriculum (pp. 13-35): ACS Publications. <https://doi.org/10.1021/bk-2022-1409.ch002>
- Kuisma, M. (2022). Bliss and Curse of Autonomy: Implementing inquiry learning in a domain-specific and cross-curricular context.
- Latipah, E. D. P., & Afriansyah, E. A. (2018). Analisis kemampuan koneksi matematis siswa menggunakan pendekatan pembelajaran CTL dan RME. *Matematika: Jurnal Teori dan Terapan Matematika*, 17(1). ISSN: 1412-5056 / 2598-8980
- Lotulung, C. F., Ibrahim, N., & Tumurang, H. (2018). Effectiveness of Learning Method Contextual Teaching Learning (CTL) for Increasing Learning Outcomes of Entrepreneurship Education. *Turkish Online Journal of Educational Technology-TOJET*, 17(3), 37-46.
- Makrasky, G., & Petersen, G. B. (2021). The cognitive affective model of immersive learning (CAMIL): A theoretical research-based model of learning in immersive virtual reality. *Educational Psychology Review*, 33(3), 937-958. <https://doi.org/10.1007/s10648-020-09586-2>
- Maksum, A., & Hani, U. (2018). Active Learning Untuk Meningkatkan Kualitas Pembelajaran. *Geneologi PAI: Jurnal Pendidikan Agama Islam*, 4(2), 169-180. <https://doi.org/10.32678/tarbawi.v6i01.2212>
- Malmia, W., Makatita, S. H., Lisaholit, S., Azwan, A., Magfirah, I., Tinggapi, H., & Umanailo, M. C. B. (2019). Problem-based learning as an effort to improve student learning outcomes. *Int. J. Sci. Technol. Res*, 8(9), 1140-1143.
- Mawarnis, E. R. (2021). *Kimia Dasar II*: Deepublish.
- Minner, D. D., Levy, A. J., & Century, J. (2010). Inquiry-based science instruction—what is it and does it matter? Results from a research synthesis years 1984 to 2002. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, 47(4), 474-496. <https://doi.org/10.1002/tea.20347>
- Naezak, N. A., Savitri, E. N., & Fibriana, F. (2021). Simple Terrarium Teaching Aid for Guided Inquiry Learning Model: The Development of Learning Instruments to Students' Concept Understanding in Global Warming and Environmental Awareness. *Journal of Innovation in Educational and Cultural Research*, 2(2), 51-59. <https://doi.org/10.46843/jiecr.v2i2.37>
- Nurdyansyah, N. (2018). *Pengembangan Bahan Ajar Modul Ilmu Pengetahuan Alam bagi Siswa Kelas Iv Sekolah Dasar*. Universitas Muhammadiyah Sidoarjo. Retrieved from <http://eprints.umsida.ac.id/id/eprint/1607>
- Peniati, E. (2012). Pengembangan modul mata kuliah strategi belajar mengajar IPA berbasis hasil penelitian pembelajaran. *Jurnal Pendidikan IPA Indonesia*, 1(1). <https://doi.org/10.15294/jpii.v1i1.2006>
- Plomp, T. (2013). Educational design research: An introduction. *Educational design research*, 11-50.
- Pollock, C. J., & Harper, N. J. (2022). Outdoor adventure education and constructive development theory: An inquiry into meaning making, growing up, and immunity to change. *Journal of Outdoor and Environmental Education*, 25(2), 247-263. <https://doi.org/10.1007/s42322-022-00107-z>
- Prafitasari, N. F., & Sulistyarsi, A. (2020). Penyusunan Modul Bioteknologi Berbasis Riset. Paper presented at the *Prosiding Seminar Nasional SIMBIOSIS*. p-ISSN : 9772599121008
- Priyanto, M., & Permatasari, D. (2022). *Students' Worksheets Based on Problem Based Learning In Composition and Inverse Functions to Enhance Conceptual Understanding*. <https://doi.org/10.15642/jrpm.2022.7.1.73-88>
- Rani, B. K., Widiyaningrum, P., & Anggraito, Y. U. (2020). Effectiveness of research based booklet media of conventional Biotechnology application as a supplement of Biotechnology teaching materials in Senior High School. *Journal of Innovative Science Education*, 9(3), 295-300. <https://doi.org/10.1294/JISE.V8I3.36051>
- Rohim, M., & Sucianto, B. (2019). The analysis of implementation of research based learning implementation in developing the students' creative thinking skill in solving dominating set problem. Paper presented at the *IOP Conference Series: Earth and Environmental Science*. <https://doi.org/10.1088/1755-1315/243/1/012143>
- Rohrbach-Lochner, F., & Marohn, A. (2018). How research-based learning can increase teacher students' knowledge and abilities—a design-based research project in the context of pupils'(mis) conceptions in science. *Research in Subject-matter Teaching and Learning (RISTAL)*, 1(1), 35-50. <https://doi.org/10.23770/rt1810>
- Schapper, J., & Mayson, S. E. (2010). Research-led teaching: Moving from a fractured engagement to a marriage of convenience. *Higher Education Research & Development*, 29(6), 641-651. <https://doi.org/10.1080/07294360.2010.489236>

- Seechaliao, T. (2017). Instructional strategies to support creativity and innovation in education. *Journal of education and learning*, 6(4), 201-208. <https://doi.org/10.5539/jel.v6n4p201>
- Selvianiresa, D., & Prabawanto, S. (2017). Contextual teaching and learning approach of mathematics in primary schools. *Paper presented at the Journal of Physics: Conference Series*. <https://doi.org/10.1088/1742-6596/895/1/012171>
- Simon, B., Esper, S., Porter, L., & Cutts, Q. (2013). Student experience in a student-centered peer instruction classroom. Paper presented at the *Proceedings of the ninth annual international ACM conference on International computing education research*. <https://doi.org/10.1145/2493394.2493407>
- Slameto, S. (2015). Pembelajaran berbasis riset mewujudkan pembelajaran yang inspiratif. *Satya Widya*, 31(2), 102-112. <https://doi.org/10.24246/j.sw.2015.v31.i2.p102-112>
- Sucianto, B., Irvan, M., & Rohim, M. A. (2019). The Analysis of Student Metacognition Skill in Solving Rainbow Connection Problem under the Implementation of Research-Based Learning Model. *International Journal of Instruction*, 12(4), 593-610. <https://doi.org/10.29333/iji.2019.12438a>
- Sulfemi, W. B. (2019). Model Pembelajaran Contextual Teaching And Learning (CTL) Berbantu Media Miniatur Lingkungan Untuk Meningkatkan Hasil Belajar IPS. *Edunomic: Jurnal Ilmiah Pendidikan Ekonomi Fakultas Keguruan Dan Ilmu Pendidikan*, 7(2), 73-84. <https://doi.org/10.33603/ejpe.v7i2.1970>
- Tan, J. C. (2016). *Project-based learning for academically-able students*: Hwa Chong Institution in Singapore: Springer.
- Towne, L., & Shavelson, R. J. (2002). *Scientific research in education: National Academy Press Publications Sales Office*. <https://doi.org/10.17226/10236>
- Tuan, L. T. (2012). An Empirical Research into EFL Learners' Motivation. *Theory & Practice in Language Studies*, 2(3). <https://doi.org/10.4304/tpls.2.3.430-439>
- Ülger, K. (2016). The relationship between creative thinking and critical thinking skills of students. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi-Hacettepe University Journal of Education*, 31. <https://doi.org/10.16986/huje.2016018493>
- Umar, A. A., Rahmi, E., Balouch, A., Abd Rahman, M. Y., Salleh, M. M., & Oyama, M. (2014). Highly-reactive AgPt nanofern composed of {001}-faceted nanopyramidal spikes for enhanced heterogeneous photocatalysis application. *Journal of Materials Chemistry A*, 2(41), 17655-17665. <https://doi.org/10.1039/C4TA03518F>
- Usmaldi, U., Amini, R., & Trisna, S. (2017). The development of research-based learning model with science, environment, technology, and society approaches to improve critical thinking of students. *Jurnal Pendidikan IPA Indonesia*, 6(2), 318-325. DOI: 10.15294/jpii.v6i2.10680
- Velez, J. J., Cano, J., Whittington, M. S., & Wolf, K. J. (2011). Cultivating change through peer teaching. *Journal of Agricultural Education*, 52(1), 40-49. <https://doi.org/10.5032/jae.2011.01040>
- Wallace, C. S., & Kang, N. H. (2004). An investigation of experienced secondary science teachers' beliefs about inquiry: An examination of competing belief sets. *Journal of Research in Science teaching*, 41(9), 936-960. <https://doi.org/10.1002/tea.20032>
- Wessels, I., Rueß, J., Gess, C., Deicke, W., & Ziegler, M. (2021). Is research-based learning effective? Evidence from a pre-post analysis in the social sciences. *Studies in Higher Education*, 46(12), 2595-2609. <https://doi.org/10.1080/03075079.2020.1739014>
- Windschitl, M. (2003). Inquiry projects in science teacher education: What can investigative experiences reveal about teacher thinking and eventual classroom practice? *Science education*, 87(1), 112-143. <https://doi.org/10.1002/sce.10044>
- Wong, S. L., & Hodson, D. (2009). From the horse's mouth: What scientists say about scientific investigation and scientific knowledge. *Science education*, 93(1), 109-130. <https://doi.org/10.1002/sce.20290>
- Zein, A., Budianti, Y., & Gea, L. F. (2022). Differences in Islamic Culture History Learning Outcomes Between Active Learning Strategies Team Quiz Type and Practice Private Madrasah Aliyah Students. *Scaffolding: Jurnal Pendidikan Islam dan Multikulturalisme*, 4(1), 47-56. <https://doi.org/10.37680/scaffolding.v4i1.1237>