

Implementation of Model 3P in Online Project- Based Learning to Assist Students' Problem Solving Skills for Biology Subjects

Ehqa Dhabita Mohd Nasir¹ , Denis Andrew¹

Fakulti Psikologi dan Pendidikan, Universiti Malaysia Sabah, Kota Kinabalu, Malaysia. ehqadhbita@yahoo.com, denisadl@ums.edu.my

Abstract—Problem solving is the way by which solutions are developed to remove an obstacle from achieving an ultimate goal. However, students' 21st century skill-focused problem-solving skills are more than just the ability to solve specific problems. Successful problem solving requires a person to be able to express opinions, argue based on evidence and be able to apply biological knowledge to real-life problems. This requires the activation of a project-based learning strategy through the application of the 4C elements, namely communication, collaboration, critical thinking and creativity. This concept paper provides a framework that enables the construction of strategies and meaning that will be done through modeling, guidance and strategy application of 4C elements in project-based learning. Project-based learning (PBL) is an educational model that prioritizes projects in teaching and learning (PdP) which is also an instructional method that allows students to build skills and gain knowledge through projects, cooperative learning and 'hands on' techniques. Through project implementation, students can build knowledge and skills through the inquiry process. The integration of project-based learning may encourage students who are unable to solve a problem by learning the strategies proposed in the phase that has been set.

Index Terms— 4C, Project- Based Learning, Problem Solving, Strategy, Biology, Skills, Inquiry

1 INTRODUCTION

PBL uses a dynamic approach so that problems and challenges in the real world can be explored by students. (Moursund 1999; Gultekin 2005; Blumenfeld et al. 1991; The George Lucas Foundation, 2012). According to Stephanie (2010), PBL is an approach that can enhance students' 21st century skills, where these skills are critical to producing a balanced human capital in terms of spiritual and physical. However, the effectiveness of PBL cannot be implemented effectively if the elements of the PBL approach are not disclosed to students during the learning sessions. Pupils were found to be unable to apply the concepts and processes of science learned in school to their daily living practices outside of school hours when teachers relied solely on textbook content (Nordine, 2007). PBL is the right choice that teachers should take as a teaching practice in the classroom as suggested by Barak and Dori (2005). Through PBL students' knowledge and skills can be built through an inquiry process to solve any problems that revolve around real life as stated by The Buck Institute for Education, BIE (2005).

21st century learning applies the concept of 4C, namely communication, collaborative, critical thinking, creativity and also 6C with the addition of 2 elements of the application of noble values and ethics according to the Malaysian context (Pendidik2u.my, 2018). These 4C skills are an important element to ensure high quality PBL construction. A study conducted by Masyuniza and Zamri (2013) found that the six components of 21st century skills studied (communication, digital age literacy, inventive thinking, effective communication, high productivity production as well as spiritual values and norms) are still at a moderate level. Therefore, these elements need to be developed and nurtured among teachers and students to ensure the achievement of high standards. Teachers are an important element because they are the implementing agents and facilitators who need to prepare themselves in ensuring the effectiveness of a learning.

Critical thinking skills and effective communication skills are essential skills in leading and facing rapid developments in science and technology. There are many challenges facing educators in this day and age. Among them is the challenge to guide students to always think creatively and critically. Biology is a subject that not only focuses on the memorisation of concepts alone, but also involves the understanding of sciences such as chemistry, physics and biology is more to the understanding of the mechanisms and processes of science supported through experiments, and inventions. All 21st century skills such as collaboration skills, critical thinking skills, creative and effective communication skills can be nurtured through activities such as problem solving and design innovation projects. The Malaysia Education Blueprint 2013-2025 considers activities based on creativity and innovation as important, where all these activities can

encourage students to always think about new solutions and create opportunities for their careers (Ministry of Education Malaysia 2017). Therefore, PPPM 2013-2025 has placed emphasis on developing creative and innovative human capital to meet the needs of the country in the 21st century.

In the face of this pandemic season, all students and teachers will implement online learning. This is to ensure that all students are not left behind in following the learning sessions and the teacher can finish the teaching topic. However, various concerns arise when wanting to implement this online teaching and learning session. This is because not all students have personal smartphones, some do not have enough internet data, some do not have direct internet access and some are unable to adapt to learning in the new norms. In addition, teachers who want to implement PBL are also worried about how to implement PBL online and most of them use the trial and error method. Not all students have the opportunity to be involved in PBL activities conducted online. Therefore, it is not surprising that there are a few students who choose to act as observers only (Siti Aloyah 2002). Whereas when all students are involved in carrying out project work hands -on learning will be more effective (Blumenfeld et al. 1991). The development of technology especially the evolution of the internet has challenged the concepts and theories of traditional education, especially the concept of classroom and teaching and learning methods (Hunt, 2004; Resnick and Wirth, 1996.) Gunasekaran (2013) has conducted a study on blended learning that is about research and application . According to him, the existence of broadband technology will further improve the quality of online learning by using various applications. Learning will be more interactive than traditional learning.

In general, the purpose of this study was to identify how the application of 4C elements in project -based learning can help students' ability to communicate effectively and problem -solving skills in the form of KBAT for online biology subjects. According to Azalya (2003), to face the challenges of globalization, Malaysians need to be equipped with various basic skills in education and strong training and have a variety of general skills including the ability to communicate, master multiple languages, critical thinking and innovative. Based on the problem statement described in the previous section, this study aims to examine in more depth how the application of 4C elements in project- based learning can help students, especially in terms of communication skills and problem solving skills in the form of HOTS for Biology subjects online.

2 LITERATURE REVIEW

Pupils' Problem Solving Skills While Implementing Project Based Learning (PBL) For Biology Subjects

Biology learning can be used to develop students' high -level thinking skills such as critical thinking. Critical thinking is a complex thought process consisting of interpretation, analysis, conclusion, evaluation, explanation and self- organization (Facione, 2011). Critical thinking is referred to as high- level thinking that encompasses the top three abilities in Bloom's Taxonomy namely the ability to analyze, synthesize, and evaluate (Bookhart, 2010; Moore & Stanley, 2010). The development of critical thinking skills can be done with open -ended questions or different questions. Open -ended questions are questions that expect many possible correct answers (Collete & Chiappetta, 1994; Subali, 2013). Nevertheless, there are studies that state that Biology subjects do not challenge the mind because the focus of learning is more in the form of memorization (B. Barron, 2000). The report of the Planning and Research Division found that overall students only used memorization techniques in the subject of Biology and as a result students did not answer questions in the form of problem solving (Ministry of Education Malaysia, 2010). Therefore, it is not surprising that students are not able to answer questions in the form of analysis and correlation. This is because learning by "deep learning" does not occur among students during the learning session because learning occurs passively and is only teacher-centered. This is even more worrying if this traditional learning continues to happen during the online learning that is happening nowadays. If this situation persists, then students' problem-solving skills cannot develop because passive learning cannot help the development of students' critical and creative skills. Pupils will continue to be listeners to the information presented by the teacher while the teacher acts as an informant. One of the learning models that develops students' critical and creative thinking skills for the subject of Biology is project- based learning. PBL not only provides students with knowledge but also enhances their problem -solving skills, critical and creative skills, future learning, communication skills, teamwork, adaptation to change, and self -assessment (Khoiri et al., 2013). In PBL, real world problems are used to push students through the problem (Farhan & Retnawati, 2014). During the problem solving process, there will be an exchange of information between students and other students so that the problem can be resolved.

The process of teaching and learning Science requires innovative and creative approaches, methods and techniques of student- centered teaching and learning and active learning among students. Creativity development aims to provide students with a variety of skills and knowledge to face the challenges of the world of work (Kind & Kind, 2007). In fact, the development of students' creativity in school has not yet reached the optimum level. This is because, the lack of attention to the development of creativity is due to the notion that creativity cannot be learned and measured. Trilling & Fadel (2009) state that creativity can be learned through a learning environment that supports questions, patience, openness to new ideas, high trust and learning from mistakes and failures. Creativity can be developed with constant practice.

3 METHODOLOGY/ METHODS

This study was conducted based on research questions; How can the application of 4C elements in online Project -Based Learning help students' communication skills and problem- solving skills for Biology subjects? To answer this question, a qualitative study was conducted. This study also examines in depth how project -based learning can help students implement online learning, issues or challenges in implementing project -based learning online, the effectiveness of communication skills and problem solving skills and evaluation of the implementation of PBL online.

3.1 3P PBL Online Model

In this study, students are expected to conduct project -based learning that incorporates 4C elements during its online implementation. Students will carry out 3 phases of PBL. The first phase, students are divided into several groups. Each group consists of students who have differences in terms of abilities, inclinations, knowledge and experience of existing students as stated in the STAD learning Model. Next, students will be exposed to the learning objectives for the field of learning as the steps recommended in the ASSURE model. Students will also be exposed to issues related to the area of learning. Afterwards, the teacher will act as a facilitator and question the students using a set of meaningful questions created based on reference to the learning objectives and questioning techniques of 5W1H. Pupils are guided to discuss and encouraged to prepare a mind map during the discussion.

In the second phase, students are encouraged to discuss and make partnerships in groups to build products. Students will share information, dialogue and use technology. The teacher acts as a facilitator to guide the students to achieve goals and agreement in the group. Next, the third phase, students will present the results of their products. Pupils are encouraged to prepare a mind map. Students will be guided to dialogue and argue about the pros, cons and improvements of the products they produce. The presentation session was conducted using a set of questions created using the 5W1H questioning technique.

3.2 Study Procedures

In the first stage, the researcher conducted a study to identify the problems faced by the students in terms of communication skills and online problem solving skills for the subject of Biology. The three methods of data collection used at this stage are to interview 6 informants, make observations based on the constructs set in the study on the six informants and make document analysis on academic achievement in semester 1, project marks (PBL) in semester 1 and evaluation level of learning (PBD) in semester 1 for these six informants (further explanation is found in appendix H). Next, the researcher will make triangulation for all the data collected. The research was conducted for 8 consecutive weeks. The implementation of the study at this stage did not involve the role of teachers because this study only focused on data related to problem identifiers

In the second stage, the research focuses on the research question, or the preliminary theory being tested. Researchers conducted a study at this stage to see how the application of 4C elements in online PBL can help students' communication skills and problem-solving skills for Biology subjects. The study was conducted for three consecutive weeks. The three methods of data collection used at this stage are to interview 6 informants, make observations based on the constructs set in the study on the six informants and make document analysis on essay marks, project marks (PBL) and learning level (PBD) for the sixth -these six informants (further explanation is found in appendix I). Next, the researcher will make triangulations for all the data collected. The following is the Study Procedure Diagram (Second Stage).

In the third stage, the research focuses on theories or findings that have been refined. The researcher will draw conclusions and determine patterns using cross- case techniques. In addition, the researcher will also focus on the comparison of PBL implementation strategies, theory and then intervene on this theory. The study was conducted for eight consecutive weeks. The three methods of data collection used at this stage are to interview 6 informants, make observations based on the constructs set in the study on the six informants and make document analysis on academic achievement on the SPM test, project marks (PBL) in semester 2 and level learning in classroom assessment (PBD) for these six informants (further explanation is available in appendix J). Next, the researcher will make triangulation for all the data collected. At this stage, teachers will not be involved because the study only focuses on the findings for the implementation of this research. The following is the Study Procedure Diagram (Third Stage).

4 DATA ANALYSIS

Interview transcripts, observation notes for PBL activities, comments, responses and conversations during discussions in telegram groups and google meet.

All data sources were analyzed using thematic analysis. Thematic analysis was used to categorize the data and form an appropriate theme to answer the research questions. This analysis begins by analyzing the data, constructing code and then presenting the data in the form of tables, maps or diagrams to facilitate the reader to examine the findings obtained.

Thinking Skills (HLTS), the researcher focuses on the elements of problem solving as stated by the Ministry of Education Malaysia (MOE), 2013. According to the MOE, HOTS is the ability to apply knowledge, skills, and values in making reasoning and reflection to solve problems, make decisions, innovate, and try to create something. Curriculum Development Division (2013), states that, the concept of assessment is the ability to apply knowledge, skills and values in reasoning and reflection to solve problems, make decisions, innovate and be able to create something. Whereas psychologists state that an individual is learning something when he is trying to solve a problem. This is because in the process of problem solving the individual will seek conclusions, apply problems in daily life, learn the law of problem solving and create some techniques or suggestions for problem solving. This process makes an individual more mature (Anderson 1993).

4.1 Classroom Assessment (PBD) and Student Academic Achievement

Classroom Assessment (PBD) and academic achievement are documents analyzed by researchers. Classroom Assessment (PBD) focuses on analysis for the review of notebooks, exercise books and projects produced by students. This review analysis is done in stages based on 3 main domains, namely the domain of knowledge, the domain of scientific investigation and the domain of scientific attitude and pure values. The level of proficiency in students for each component in this excel template is recorded for the purpose of reporting the progress of student learning for a certain period, namely the middle and end of the year. Assessment is done all the time and the level of proficiency in students is monitored on an ongoing basis. This level of proficiency is recorded in a record book, or other place of record and reported twice a year, ie in the middle of the year and at the end of the year.

4.2 Student Academic Achievement

Researchers also obtained information and data related to students' academic achievement in the summative examination and SPM trial examination for the subject of Biology in the form of documents. Among them are analysis of marks for examination questions, analysis of test specification tables and headcount of student results. The defined document is in the form of a written text (Cortazzi, 2002). Silverman (2000) has stated that document analysis is a written storage material such as books, magazines and newspapers. While the analysis of unwritten documents is like video, audio and film recordings. Additionally Suseela (2001) has stated that document data are available from a variety of sources. Therefore, the researcher will obtain document data related to students' problem -solving and communication skills through records of students' academic results in the subject of Biology. The record of this document is important to assist researchers in strengthening support for the study conducted later. In addition, the researcher also compared the academic results of students for the Biology subject examination in 2021 through the headcount document in the google drive of a school in Kota Kinabalu. A continuous analysis of the improvement of students for the subject of Biology is made from the results of the summative examination until the trial examination of SPM 2021 (further explanation in appendix K).

4.3 Results and Discussion

1. Analysis of Observations on Respondents' Activities While Implementing PBL Online

Problem Solving Criteria	Identify Problem	Defined Problem	Create Strategy Statistics	Create Strategy	Product Effectiveness
Fara	Yes	Yes	Yes	Yes	Yes
Des	Yes	Yes	Yes	Yes	Yes
Col	Yes	Yes	Yes	Yes	Yes
NG	Yes	Yes	Yes	Yes	Yes
Adam	Yes	Yes	Yes	Yes	Yes
Fun	Yes	Yes	Yes	Yes	Yes

The figure above shows that all respondents were able to identify problems and define problems when implementing PBL online. In addition, they can also make statistics on the implementation strategy of PBL and implement the strategy. Next be able to produce creative and functional work. In addition, they also showed an understanding of the projects they were implementing through the responses given during the online PBL implementation. The six respondents interacted with each other, dialogued, asked about issues related to daily life and discussed while performing problem-solving processes. Pupils are able to be actively involved in the learning activities they participate in. It is clear here that through exposure to the problem-solving process during learning sessions, students are able to actively engage in the activities in which they participate.

4.4 PBL Draft Analysis

Name	Draft
Fara	Yes
Des	Yes
Col	Yes
NG	Yes
Fun	Yes
Adam	Yes

The figure above shows that all respondents prepared a draft of PBL work before implementing PBL online. As defined in the Malay dictionary, a draft is a writing or drawing prepared roughly at the initial stage or beginning of the implementation of a work. This shows that all respondents make preparations or planning while implementing PBL face to face.

4.5 Interview Analyse

The following are the statements made by the respondents related to the 3P model. Among the things that drive communication, collaboration, creative and critical skills are the speaking opportunities provided

by teachers. In addition, project -based learning is best done in groups as it encourages communication, collaboration, creativity and critical skills among group members. Open and focused questioning techniques are also able to encourage students to collaborate with each other. This in turn encourages students to express opinions, ideas, make connections and explain something based on evidence.

"...what is the factor ... that helps you to communicate actively?..."

[T1_TC_1]

"... when ... given the opportunity to share opinions or ideas, I can go through the results of the information search that I do..."

[T1_DS_1]

"... When I am given the opportunity ... I will feel appreciated because... it seems, all the information I am looking for, I can share with other friends through the opportunity to give an opinion... hmm, and I feel more confident to do PBL in groups..."

[T1_CL_1]

"...I will interact with my group members through direct question and answer... we can work with each other and give each other's opinions..."

[T1_FR-1]

"...open-ended questions and answers conducted by teachers, allowing us to express our opinions with each other's explanations..."

[T1_AD_1]

"...on the other hand, express my opinions and talk more in groups when implementing a new project, especially issues related to daily life... because it's not boring, it even encourages me to interact more actively to get information ... hmmm... talk more actively..."

[T3_AD_1]

In addition, PBL issues that are not related to the content of the textbook are also able to encourage students to apply the 4C elements in learning sessions. This is because, through issues related to real world problems, they have the opportunity to conduct the research process more closely. They can also understand a biological concept in more detail. This in turn encourages students to innovate through the implementation of PBL. It is clear here that the implementation of PBL is also able to encourage students to apply their imagination and creativity.

"...what are the factors that motivate you to conduct question and answer sessions while implementing PBL?..."

[T1_TC_1]

"...hmmmm... I have a lot of question and answer with other group members because this issue is very interesting and not unrelated to textbooks... through this issue, only then did I know apparently the concepts I learned all this time have something to do with my daily life..."

[T1_FR_1]

"... before this, I just listened and focused on what the teacher in front of the class said ... I just kept quiet and focused... that time, I don't know what I've learned so far has anything to do with with daily life. But, through PBL... I can clearly see the relevance of a concept to my daily life... because I ask a lot of questions and share information with other group members..."

[T2_DS_1]

"...PBL provide the opportunity for me to implement the project. So, to find the solution... I ask a lot of questions and share information and experiences with other group members... I get more information... the more I learn from these questions and answers, the more questions arise in my head about this concept..."

[T2_FR_1]

"...questions asked by the teacher while he was monitoring us making PBL in groups helped us to stay on track... we were able to implement PBL effectively because our investigation focused on the results of the teacher's guidance... n were able to eat again..."

[T3_AD_1]

"... when we discuss a new and life -related issue... at least we know this thing is useful and it works... then we can apply it in our daily routine..."

[T1_FD_2]

"... me too tcer... I prefer if PBL uses open -ended but focused questions because I can find out something new in more detail and thoroughly..."

[T9_CC_1]

"... when we were guided... he really helped me and my friends to find information in a focused way than before, I only implement passive learning... so an observer ..."

[T10_CC_1]

In addition, the role of the teacher as a facilitator is also able to ensure that the implementation of a learning can be implemented systematically and effectively.

"... tcer time to be a facilitator... tcer can guide us... then we have a guide to make pbl..."

[T11_NG_1]

"... when tcer acts as a facilitator... we can stay on track... we can implement PBL effectively because our investigation focuses on the results of teacher guidance ..."

[T11_AD_1]

"... I prefer the teacher to function as a facilitator rather than the teacher just giving an explanation in front of the class ..."

[T11_CC_1]

"... it's very interesting and encourages me to think of more new things that have to do with the biological concepts I'm learning ..."

[T13_NG_1]

Even so, during the execution of group work, task specifications need to be implemented. This is important to prevent group members from taking advantage of the abilities of other group members. In addition, it can also prevent the domination of work by certain individuals.

"...so in group work... if there is no task specification... does anyone take advantage? ..."

[T2_TC_1]

"... yes ... tcer... Even before this, I just sat and waited for other friends to complete group projects, then, some didn't do it right... because I don't feel like there is back up too... so, when the teacher for us the task specifications in detail, I feel more responsible and I know bah... focus of the project that I need to complete in groups..."

[T2_DS_1]

"...hmmm... Teamwork trains us to talk to each other, share information, and make decisions together..."

[T2_FR_2]

Responses from participants showed that they were more motivated to resolve an issue in PBL that was related to real life and not tied to the content of the textbook. Issues that revolve around real life expose students to problem-solving processes. Therefore, students can understand a concept and the relationship of the concept of biology with real life clearly. Students will appreciate knowledge more when they can understand the benefits of that knowledge to them. Therefore, teachers need to be more creative in the selection of issues or problems while using project -based learning methods. This is important to ensure that a biological concept is widely and deeply exposed. If the teacher only relies on the content of the textbook alone, students will feel bored and continue to be passive from engaging in learning activities carried out.

"... high curiosity encourages us to ask more questions, sharing knowledge and experience ..."

[T4_DS_2]

"... Example kan tcer... when we share information... I can further develop the idea that I am... through the sharing of knowledge and experience... our discussions are so more detailed... and broad..."

[T5_NG_2]

"... I just listened and focused on what the teacher in front of the class said ... I just kept quiet and focused... that time, I didn't know what the function and relevance of the concepts I learned was to my daily life.... I've been bored for a long time... but when I do PBL online... I do pbl guided... I know what I need to focus on... we can discuss... we collaborate... and I'm excited to create a new product ... "

[T6_DS_2]

"... I'm a tcer... Pbl online encourages me to interact more and have a dialogue... because we both discussed compare from before... I just became an observer and just did what was instructed..."

[T6_CC_1]

One of the aspects that need to be considered when implementing PBL online is the student scoring system. Preferably the scoring system is implemented individually and in groups. This is important to ensure continued commitment from each member of the group. They will continue to collaborate, communicate, discuss, dialogue and exchange views to produce projects that work best. This also encourages students to be actively involved in the learning activities in which they participate. They will be more motivated to implement project -based learning.

4.6 Document Analysis

Examination Marks

Analysis of SPM Trial Examination Marks

Name	Paper 1	Paper 2	SPM Trial Test Results
Fara	35	65	71 (A-)
NG	33	67	72 (A-)

Adam	37	72	78 (A-)
Des	30	54	60 (B)
Col	35	72	76 (A-)
Cel	38	76	81 (A)

Comparison of Semester 1 Examination Marks and SPM Test

Name	Semester One Result	SPM Trial Result	Comparison
Fara	44	71	+27
NG	59	72	+13
Adam	51	78	+27
Des	43	60	+17
Cel	60	76	+16
Col	55	81	+26

Based on the figure above, all respondents showed a significant increase in marks in the semester 1 examination and the SPM trial examination. All respondents got A- and A grades, while another respondent got a B grade. This shows that all respondents can achieve the optimum level in the SPM trial semester examination. All respondents have been able to get used to answering questions in the form of easy, medium and KBAT in the SPM trial examination. This is because the percentage of preparation of questions in the form of KBAT for this examination question is 40%, the percentage of preparation of simple questions is 20%, while the percentage of preparation of medium questions is 40%. In addition, all respondents indicated that they have mastered at least 50% in the learning syllabus in semester 2 for the subject of Biology. This is because respondents can understand the content of learning that they learn and there is an improvement in students' problem -solving skills.

4.7 Pupils' Learning Levels in Classroom Assessment (PBD) and Project Marks of Semester 2 Respondents

Level of Learning (PBD) and Project Marks of Respondents Semester Two

Name	Semester Two Level	PBL Project Mark
Fara	6	92
Ng	5	96
Adam	5	92
Des	5	90
Cel	6	96
Col	5	90

The figure above shows that all respondents were able to achieve levels five and six in classroom assessment (PBD) in semester 2 for the subject of Biology. Respondents who achieved level five of learning in PBD showed respondents were able to formulate how concepts are used to address a particular problem or issue, formulate the effects of a problem, and always use scientific language to communicate with them. well and document all sources of information used. While level six shows students who can formulate how concepts are used to address a particular problem or issue, discuss, and analyze concepts to solve a particular problem, use scientific language consistently to communicate clearly and accurately, document information sources and be role models to other students.

5 CONCLUSION

It is recommended that students be aware of and use the various forms of support provided by peers, teachers, schools or existing technology available to them. teachers should also promote a constructivist learning environment by taking into account three main principles namely pedagogical, social and technological aspects. Teachers must ensure that the rules and strategies implemented can be clearly defined.

Therefore, to improve the quality of communication, necessary facilities such as better internet connection should be provided, or improved to ensure that online support can be fully utilized by students.

6 ACKNOWLEDGEMENT

This paper and the research behind it would not have been possible without the exceptional support of my supervisor, DR. Denis Lajjum. His enthusiasm, knowledge and exacting attention to detail have been an inspiration and kept my work on track from my first encounter with the draft of 21st Century Learning to the final draft of this paper.

My colleagues at University of Malaysia Sabah, Jabatan Pendidikan Negeri Sabah and school community at SM. Lok Yuk Kota Kinabalu, especially the principal of Pn. Lourdes Mary Batin who have also looked over my transcriptions and answered with unfailing patience numerous questions about the research. Pn. Norah Marcus, education officer of the Jabatan Pendidikan Negeri Sabah currently resides, not only provided ideas of the manuscript overnight, but unexpectedly shared the invaluable information on the problem based learning issues that she has been gathering for almost twenty years.

I am also grateful for the insightful comments offered by the anonymous peer reviewers at Books & Texts. The generosity and expertise of one and all have improved this study in innumerable ways and saved me from many errors; those that inevitably remain are entirely my own responsibility.

7 REFERENCES

- Jeremy L. HSU, Stanley M. LO, Brian K. SATO. (2021). Defining Understanding :Perspectives from Biology Instructors & Biology Education Researchers. *The American Biology Teacher*, No. 6.
- Ismail, Anita, Muda @Ismail, Farah Laili, Sulaiman, Adibah, Mohd Nizah, Mohd Azmir, Abdul Latiff, Latifah, Sulaiman, Mashitah, Mat Yaacob, Siti Norbaya, Kandil, Hisham Mohammad Taky Eldin, (2020). Pembentukan Pemikiran Kreatif dan Kritis. Hubungannya Dalam Menyelesaikan Masalah. *Sains Insani*, 5(1).
- Mohammad Hazim Amir Nordin. (2020). The Culture of Learning Continuum : Promoting Internal Values In Higher Education. *Journal of Studies In Higher Education*.
- Norhasyimah Hamzah, Siti Nur Kamariah Rubani, Arihasnida Ariffin, Normah Zakaria & Fazrulhelmi Ahmad. (2020). Kaedah Pembelajaran Abad Ke-21 (PAK-21) Secara Atas Talian Dalam Subjek Psikologi Pendidikan. (*Buku Kurikulum dan Instruksi Siri 11, Universiti Tun Hussein Onn Malaysia*). Bab 4,27-36. Diambil semula dari https://fptv.uthm.edu.my/images/journal_book_chapter/full_book_chapter_Siri_11_latest.pdf
- Muhammad Sabri Sahrir, Nurulhuda Osman, Ilyani Syiham Muhammad. (2020). Aplikasi 'Konsep 4C' Pembelajaran Abad Ke-21 Dalam Kalangan Guru Pelajar Sarjana Mod Pengajian Pendidikan Bahasa Arab Cuti Sekolah UIAM. e-Jurnal Bahasa dan Linguistik. Diambil semula dari e-Jurnal Bahasa dan Linguistik (e-JBL) (kuis.edu.my)
- W. Sumarni and S. Kadarwati. (2020). Ethno-Stem Project-Based Learning: Its Impact To Critical And Creative Thinking Skills. *Jurnal Pendidikan IPA Indonesia*, 11-21.
- Ulfi Indriyani. (2020). Upaya Meningkatkan Keterampilan Komunikasi Siswa Dalam Pembelajaran Sejarah Melalui Strategi Giving Question Getting Answer. *Jurnal Sejarah dan Pendidikan Sejarah*, 9 (1). 2020. 85-94.
- Nor Khayati Basir, Mohd Isa Hamzah, Khadijah Abdul Razak. (2020). Sikap dalam Pendekatan Pembelajaran Berasaskan Projek Terhadap Pencapaian Pelajar Politeknik di Negeri Perak. *ResearchGate*. Diambil semula dari https://www.researchgate.net/publication/345150558_Sikap_dalam_Pendekatan_Pembelajaran_Berasaskan_Projek_Terhadap_Pencapaian_Pelajar_Politeknik_di_Negeri_Perak
- Joseph, Suresh Kumar, Alimon, Hashimah, Yusoff, Amri. (2019). Learning Biology through Digital Games (DG) in Form Four Classrooms in Malaysia. *Journal of Science and Mathematics Education in Southeast Asia*, 42.
- Wong Weng Siong. (2018). Pembelajaran Berasaskan Permainan dalam Pendidikan STEM

- dan Penguasaan Kemahiran Abad Ke-21. *Politeknik & Kolej Komuniti Journal of Social Sciences and Humanities*, Vol. 3, 2018
- Nargis, Armelia, Lisa, (2018). Optimizing EFL learners' communicative competence through short movie project. *Asian EFL Journal*, 20(5).
- Nindiya Eka Safitri. (2018). Meningkatkan Teamwork Skills Melalui Layanan Bimbingan Klasikal Berbasis Cooperative Learning. *Tajdidukasi*, Volume VIII, No. 1.
- Kamisah, Osman, Siti Mariam, Zazam, (2017). Pengetahuan dan kemahiran guru Sains sekolah rendah terhadap pemupukan Kemahiran Berfikir Aras Tinggi (Kbat) dalam pembelajaran. *ResearchGate*.
- Halim, Mohamad Nizam Arshad dan Abdul, (2017). Menjana kemahiran berfikir aras tinggi (KBAT) dalam penyelesaian masalah matematik tambahan. *Universiti Teknologi Malaysia*.
- Akhtar H, Abdul Ghani Azmi I, (2017). Komunikasi kepimpinan berkesan. *Jurnal syariah*, 25(3).
- Amir, Aris, Ahmad Rozelan, Yunus, (2016). Komunikasi Berkesan. *ResearchGate*.
- Fazilah Binti Razali, Othman Bin Talib, Azraai Bin Othman. (2016). Aplikasi Kemahiran Proses Sains Dalam Pembelajaran Berasaskan Masalah Untuk Mata Pelajaran Biologi. *Jurnalkurikulum & Pengajaran Asia Pasifik*, Bil 4, Isu 3
- Maimunah Binti Nasir. (2016). Pembelajaran Berasaskan Masalah Dan Amalan Pembelajaran Arah Kendiri Ke Arah Perubahan Kefahaman Murid Tingkatan Enam Dalam Konsep Genetik. (*Tesis Doktor Falsafah, Universiti Sains Malaysia*). Diambil semula dari http://eprints.usm.my/31557/1/MAIMUNAH_BINTI_NASIR_24.pdf
- Nor Ezah Binti Ariffin, Nurulwahida Binti Hj. Azid @ Aziz. (2016). Persepsi Murid Tahun Lima Terhadap Penggunaan Kaedah Model Bar Dalam Penyelesaian Masalah Matematik Berayat Tajuk pecahan. *International Seminar on Generating Knowledge Through Research*, 1 (2016), 287-304
- Sumarni W. (2015). The Strengths and Weaknesses of the Implementation of Project Based Learning: A Review. *International Journal of Science and Research (IJSR)*, 4(3).
- Aziza Kavlu. (2015). Implementation of Project-Based Learning (PBL) in EFL (English as a Foreign Language) classrooms in Fezalar Educational Institutions (Iraq). *5th International Research Conference on Education*, ISSN 2298-0180.
- Fazliza Binti Che Mat. (2015). Kesan Pengajaran Dialogik Terhadap Kemahiran Menaakul Sainifik, Kemahiran Berhujah dan Pencapaian Sains Dalam Kalangan Murid Sekolah Rendah. (*Tesis Doktor Falsafah, Universiti Sains Malaysia*). Diambil semula dari <http://eprints.usm.my/31391/1/FAZLIZA.pdf>
- KPM, (2015). Kemahiran Berfikir Aras Tinggi (KBAT) dan Perlaksanaan KBAT di Sekolah. *Buletin Anjakan*.
- Zakaria, Suhaimi, Othman, Aris, Baharuddin, Mohammed, Hasnah, Zaid, Norasykin Mohd, Abdullah, Zaleha, (2014). Penerapan kemahiran berfikir aras tinggi melalui model stesen rotasi pelbagai mod. *Konvensyen Antarabangsa Jiwa Pendidik*.