Article

EAQD-PC: Learning Model to Train Students' Metacognitive Skills to Overcome Difficulties in Learning Biology

Nurmi*[1,2], Herawati Susilo[1], Ibrohim[1], Suhadi[1]

[1] Department of Biology Education, Faculty of Mathematics and Natural Sciences, Malang State University, Malang 65145, Indonesia; herawati.susilo.fmipa@um.ac.id (H.S); ibrohim.fmipa@um.ac.id (I.); and suhadi.fmipa@um.ac.id (S)
[2] Department of Biology Education, Faculty of Teacher Training and Education Science, Muhammadiyah Bone University, 25786 South Sulawesi, Indonesia
* Correspondence: nurmi@unimbone.ac.id

Abstrak: Biology is so complex that it has to be studied in different ways and focuses on processes. Self-regulation skills in learning are important metacognitive skills for students in studying Biology. Learning models that train strategic students in learning are a must so that they gain meaningful learning experiences through the process of exploration, analysis of new information carried out in learning by applying self-questioning strategies to monitor why new information can be trusted. The results of the synthesis between old knowledge and new knowledge are enhanced through peer coaching in class. This research was conducted to develop an EAQD-PC learning model (exploring, analyzing, questioning, defining peer coaching) and tools that are valid, practical, and effective. The model development procedure includes the preliminary research stage, the prototype stage, and the assessment stage. Model validation data was collected using expert validation instruments. While the practicality of the model components is measured by the implementation observation sheet. The effectiveness of the model was measured using a metacognitive skill test and a questionnaire. This model is applied to students majoring in Biology Education at Muhammadiyah University of Bone, even semester 2019/2020. The results showed that the components of the EAQD-PC model (a) with a value of 3.87, and valid learning model supporting tools with a value of 3.83, (b) practicality with a value of 3.89 and (c) effectiveness with a value of 3, 97. This study proves that the EAQD-PC model is practical and effective for training students' metacognitive skills.

Keywords: EAQD-PC; Metacognitive skills; train and learning model

INTRODUCTION

In the 21st century students are faced with the challenges of extreme global competition, knowledge and technology develop automatically [1]. This condition is a challenge for the education system to equip students with 21st century skills and student teacher candidates must be equipped with 21st century knowledge and skills so that they are competent and successful in life and careers [2]; one of these skills is critical thinking skills as a metacognitive process [3].

Research shows that the learning approach in Indonesia is generally not oriented to the learning process that trains the 21st century skills of prospective teacher students [4], [5], [6], [7]. Their lecturers (including biology lecturers) only focus on the subject matter and the completeness of the sub-sub-discussions of the material. they ignore the development of learning skills in their learning. This approach to learning ignores strategies to help learn how students learn to understand. Tanner[8]'s findings about the claim of most lecturers that their job is only to teach biology, not teaching learning strategies. Student claims are equally bad that the biology course is a rote course about facts and scientific names [9], . Therefore, learning biology needs an approach that makes a difference and is more effective to improve the 21st century skills of prospective biology teacher students [10], [11]. One of the skills in question is metacognitive skills (self-regulation).

Metacognitive skills help students strategically in approaching assignments and improve their critical thinking and creative thinking skills in learning [12]. Metacognitive skills are important because they help students learn strategically independently [13] so that it is easier to understand new and even more complex information [3]. Therefore metacognition is very important for biology students to analyze the complexities of biological systems which include multilevel interactions of "structure, behavior and function" [14] and are difficult to relate to real life [9] [15], [16]. For this reason, metacognition skills are needed for learning biology, especially plant physiology. Plant Physiology as one of the compulsory subjects for prospective biology teacher students. The complexity of this course facilitates the training of metacognitive skills. Thus, plant physiology and metacognition are an excellent match between learning tools and those who want to be studied. The complexity of the two forms a symbiotic relationship of mutualism in facilitating each other's success in achieving each other's results.

For example: in this study, students were divided into two very different story options (inspired by Tanner [8] which was also inspired by Ertmer & Newby [17]. Imagine yourself as a lecturer in plant physiology biology; - at the end of this study, before the assessment was given Nina (a pseudonym) stated that she was very excited, she learned very well therefore she could answer any question when asked. He felt that he had made all efforts to complete the reflection of his learning results very well. She studied very hard so she wanted good grades. Unlike Nurisa, she said that she was not initially interested in this approach, and the material was also difficult to understand she said the first meeting of the second she was very confused because it was difficult to understand the material and the approach/model used was also difficult to do but she continued to learn, looking for explanations relevant to the themes learned from the internet and from other learning resources and asked for explanations related to the model and finally at the third meeting he began to understand. She said I was very happy she said this new model not only taught us Plant Physiology but more importantly we were taught how to learn, we were taught critical thinking. he hoped that this could be applied to other courses. These college students don't care about the end-of-semester grades. The two of them are very different in using the way of learning to learn (metacognition approach) in their learning.

Based on the example of the two students, it shows that metacognition is very important for prospective teacher students to produce teachers who have metacognitive skills -metacognitive knowledge and regulation to become effective learning – able to design, monitor and assessing learning for its success [18], [19]. Metacognition can also overcome the bad habits of students who have a tendency to stop learning before they fully understand what they are learning [20]. Metacognition helps students not to survive in an unproductive approach [8] because with metacognition skills (knowledge, regulation and metacognition experience) students are able to self-regulate their learning [21] for which students must be taught metacognitive strategies, through an explicit, and wise approach - that is, integrating metacognition into the structure of biology learning and even learning anything so that they are aware of when and where a metacognitive strategy is used – for example identifying what they have not understood in a previous task [22], [23]. This allows metacognition to become part of the language and daily habits of lecturers and students.

To answer the challenges of the automatic development of digital knowledge and technology today. It requires teachers and or prospective teachers who have metacognitive awareness and skills. To meet the need for metacognitive teachers, it is the prospective teacher (teacher) students who must be prepared and trained

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 22 December 2022 doi:10.20944/preprints202212.0430.v1

in advance so that they have metacognition awareness and metacognitive skills. To realize these expectations, an explicit and wise metacognition integrated learning approach is needed through the development of learning models to train student metacognition.

The metacognitive integrated learning model that the author intends to train student metacognition is the EAQD-PC learning model. What and why EAQD-PC? Let's see why! EAQD-PC is an acronym *for exploring*, *analyzing*, *questioning*, *defining*, and peer coaching. This EAQD-PC instructional model was developed to be one of the effective options in training metacognition skills (knowledge and regulation and experience of metacognition [24] students, these three aspects of metacognition can be distinguished but inseparable because they work complementary so that each aspect is equally important without being excluded. Those metacognition attributes become each stage of the model's syntax; - exploring (E). Exploration is an inquiry process guided by curiosity and driven by reflective critical thinking [25] is a strategy for building knowledge of student metacognition by digging deeper [27], [28], [29], [30], [31] and assessed that exploring is one of the indicator of creative thinking because in the process of exploration new ideas are discovered [32], [33], [34], analyzing (A) at this stage is carried out clarification and analysis of the results exploration of things taken from how science scientists work- for example in science learning students must understand how science scientists work in making observations of natural phenomena by observing and comparing, hypothesizing (the process of analyzing) and formulating explanations in finding valid answers and questioning (Q) is a strategy of training students' metacognitive knowledge and regulation so that they do not stop learning before actually mastering [20] at this stage also students are trained to plan and evaluate their learning [6]; defining (D) is a strategy for knitting metacognition experiences [35], [21] and finally peer coaching as a strategy to reflect the results of all stages of the model [36], [37]. Therefore, the development of this model aims to facilitate the training and development of student metacognition.

1. **Method**

This research is a research and development patterned on the development model of [38]. The development procedure is carried out through three stages; first the preliminary research stage, the second stage of making the basic form of the model, and finally the assessment stage.

1.1. Preliminary research stage

In this preliminary research, a study of several supporting aspects needed for model developers was carried out, along with the studies carried out;

a. identifying the learning model used by biology education lecturers, Faculty of Education and Science, University of Muhammadiyah Bone, South Sulawesi Indonesia. At this stage, a study of relevant learning theories was also carried out as the basis for developing the EAQD-PC model. Empirical studies were also conducted with interviews about course learning tools. The results of this study become a conceptual framework for the development of the EAQD-PC model to be applied in training students' metacognitive skills.

b. reviewing the profile of students' metacognitive skills. Student metacognitive skills profiles are obtained by using a questionnaire of metacognitive skills synthesized by students.

c. needs analysis of learning tools used by biology lecturers. The learning tools analyzed include: Semester Learning Plans, Learning Program Units, and Student Activity Sheets. The results of the analysis are used to develop new learning tools that support the development of the EAQD-PC model to be applicable.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 22 December 2022 doi:10.20944/preprints202212.0430.v1

d. analyzes the development of instruments. Analysis of instrument development theory is carried out to form the basis of new learning tools according to the characteristics of the EAQD-PC model for the validity, practicality and effectiveness of the model.

1.2. Prototyping stage

The prototyping stage consists of the design stage, the realization of the prototype construct, as well as the validation and revision of the product. The activities carried out at this stage are to design the components of the EAQD-PC model which are from syntax, social systems, reaction principles, support systems – such as learning conditions when implementing the model which includes classroom management, learning systems and tools or media, and the impact of instructional and accompaniment impacts. Product validation format and modified observation sheet from [39]. The design of the instrument consists of a questionnaire of the meta-cognitions of Schraw & Dennison [40] and refers to the self-question developed by Tanner [8]

Prototypes that have been created and acted upon into the application of learning. Phase I produced the basic prototypes of the EAQD-PC model, learning tools and research instruments. The form of the EAQD-PC learning model is in the form of: (1) syntax as learning stages; (2) the establishment of a social system; (3) regulation of the principle of reaction; (4) instructional impact; (5) the establishment of support systems;(6) the regulation of the social system of instructional impact. The devices used to realize the EAQD-PC model consist of (1) SAP, the structure includes identity, learning objectives, indicators, learning models, learning stages, learning tools, learning resources and assessments, and (2) MFIs. Application of research instruments (1) validation sheets, (2) observation sheets, (3) student questionnaires, (4) inventory (5) metacognitive skills instruments.

The activity carried out at the validation stage is to validate and revise prototype 1 to produce prototype 2 by two learning model experts and one Plant Physiologist. Validated prototypes are piloted at the assessment stage. Learning tools, draft model books and research instruments in the validation process are revised according to expert advice. Product validation categories can be shown in Table 1.

Table 1. Product Validity Category

Criterion	Category
1≤ Va < 2	Invalid
2 ≤ Va < 3	Less valid
3 ≤ Va <	Quite valid
4 ≤ Va < 5	Valid
Va=5	Very valid

Va = average score

Small group trials were carried out as many as three meetings on cell biology material (mandatory courses before the Plant Physiology course) to identify possible problems that would arise in the process of applying the EAQD-PC model. Revisions were made once again according to the results of small group trials and the advice of expert validators. The second revision resulted in prototype 2.

1.3. Assessment Stage

The assessment stage aims to determine the practicality and effectiveness of the EAQD-PC learning model. Model practicality data is data on the suitability of model components with the process of implementing a model into learning. The data on the effectiveness of the model were obtained from the N-gain value achieved after the learning model was applied and from the responses of lecturers and students during the learning process with EAQD-PC. The EAQD-PC learning model was applied to the Plant Physiology course 11 times. Five observers observed the model implementation process. The implementation uses a one group pretest-post-test design see in figure 1. Pretests are carried out before treatment is carried out to test students' metacognition skills.

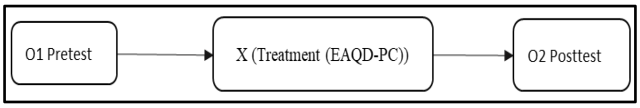

Figure 1. Research Design [41]. EAQD-PC: Exploring, Analyzing, Questioning, Defining – Peer Coaching

2. Participants

The participants in this experimental study were 33 students (from class A) who were registered in the 2019/2020 semester at the Department of Biology Education, University Muhammadiyah Bone, South Sulawesi, Indonesia. All participants agreed to participate in the study before a pretest was given. Vice Chairman of the Academic Section of University Muhammadiyah Bone (No.210 / KET / II.3.AU / A / 2019).

3. Data analysis

The practicality of EAQD-PC can be determined if consistency between the intended perception (IP) and the intended operation (IO) is obtained from validators and observers. The IP obtained from the validator and the IO obtained from the observer meet the criteria of the measurement table. The measurement table can be seen in Tabel. 2

Table 2. Criteria for the practicality of the product

IP value interval	**Category**
1≤ **LP**<2	Impractical
2≤ **LP**<3	Less Practical
3≤ **LP**<4	Medium
4≤ **LP**<5	Practical
LP=5	Very Practical

Description: Practicality level

The effectiveness of EAQD-PC is assessed based on students' metacognitive skills after training through the application of the model. Results of pretest and posttest metacognitive skills analyzed uses normalized gain to get an N-gain score. The categorization of N-gain analyses is presented in Table 3.

Table 3. N-gain score criteria

N-Gain Score	**Criterion**
0.30 ≥ g	Low
0.70 ≥ g > 0.30	Medium

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 22 December 2022 doi:10.20944/preprints202212.0430.v1

G >0.70	Tall

EAQD-PC is considered effective in training students' metacognitive skills if the mean N-gain value is reached > 0.30 or is in the medium or high category. The effectiveness of the learning model is also determined based on the responses of lecturers and students The model is declared effective if 70% of students give a positive response to the model and a positive lecturer response of at least 70% of the questionnaire items from each aspect studied.

3. Result

3.1. Preliminary Research

3.1.1. Preliminary Investigation of Learning Models

The survey results show that most lecturers apply a constructivist learning approach. The results of the syllabus analysis from several different institutions almost entirely use conventional integrated cooperative learning models and problem solving, namely lecture methods combined with group tasks to be discussed and presented in front of the class. But here problems arise in group assignments because most students become irresponsible for their own learning. Most of them do not actively participate in completing tasks but only write their names on the paper. This also has an impact on the absence of mutually beneficial interdependence between students. Finally, social-emotional discomfort arises between students in a group. Another negative impact is that judgments are not objective. Based on the results of observations and interviews, the development of independent learning through metacognition training [13], [15] proved indispensable for all content and levels of Education.

The EAQD-PC learning model was developed to meet those needs. This EAQD-PC learning model aims as a tool to train students' metacognitive skills. This model was developed based on constructivist learning theories, - such as Piaget's theory of cognitive development, Vygostky's theory of social interaction, Jerome Brunner's theory of discovery learning, Gagne's theory of information processing, and Ausubel's theory of meaningful learning [42], [43] These learning theories aim to build learning independence for each student.

3.1.2. Profile of Student Metacognitive Skills

In general, students of biology education Muhammadiyah Bone University South Sulawesi Indonesia, have a metacognitive skills score in the moderate category. The results of statistical analysis show that there is no difference between other universities. These findings form the basis that the learning process must be empowered and improved through the development of learning models that are integrated with higher-order thinking skills, especially metacognition. Metacognition is integrated into the learning curriculum to train students to support their success in learning.

Most of the students of Muhammadiyah Bone University have exploration power in learning in the medium category 44 (80%), only a few are in the high category 5 (9.1%), and almost all categories in the low category 6 (10.1%). These findings illustrate the importance of training in learning how to learn (metacognition), learning to reason and analyze in learning. Independent learning integrates metacognition into learning through the development of learning models. This aims to train students' metacognitive abilities to be successful in learning and become exploratory independent learners.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 22 December 2022 doi:10.20944/preprints202212.0430.v1

3.1.3. Observation results of Learning Tools

The results of the observation of learning tools show that lecturers have equipped themselves with learning tools in the form of syllabus, SAP, MFIs and assessment tools. However, the device has not facilitated the training of students' metacognition skills. MFIs have not fulfilled the awareness of metacognitive consciousness so they cannot train students' metacognitive abilities. Assessment still focuses on cognitive assessment of memorization (C1), comprehension (C2) and application (C3).

3.1.4. Observation results of learning instruments

The development of the EAQD-PC model begins with the theory of learning development to support the achievement of the validity, practicality, and effectiveness of the EAQD-PC model. The validity of the model device is measured through expert and practitioner validation using validation sheets. The practicality of this model is measured through the assessment and application of the EAQD-PC learning model. The measurement instruments used are metacognitive tests and questionnaires, lecturer questionnaires and student questionnaires.

3.2. Prototyping phase

3.2.1. Product Development

The steps of learning activities carried out in the EAQD-PC model consist of exploiting, analyzing, questioning, defining, and peer coaching (PC) activities as reflections. Activities based on model syntax are shown in Table 4.

Table 4. Student Activities on EAQD-PC

Syntax	Student Activities
Exploring	▪ Students explore content outside of class hours guided by questions (cognitive strategies) to control understanding of the text and the limit of comprehension achievement (metacognitive strategies);
Analyzing	▪ Further analyze the exploration results that have been recorded which are also guided by questions (metacognitive strategies) to monitor the understanding of the text;
Questioning	▪ Again the question is done to assess understanding both to make cognitive progress (cognitive strategies), and to monitor them (metacognitive strategies)
Defining	▪ Students build understanding of the text being explored by paraphrasing the text from their exploration and continuing to monitor the suitability of meaning
Peer Coaching	▪ Students guide each other and foster each other in advancing and monitoring their cognitive understanding. This stage as a process of reflection of the results of all stages.

Developed by researchers

3.2.2. Expert Validation Results

Professionals evaluate the EAQD-PC learning model to assess the feasibility of model components, support systems, syntax, social systems, roles and duties of lecturers in the implementation of learning, support systems and learning impacts. The results of expert validation

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 22 December 2022 doi:10.20944/preprints202212.0430.v1

stated that the model was valid with a score of 3.87. This suggests that the model requires only minor revisions. The validation results are shown in Table 5:

Table 5 Model Component Validation Results

Evaluated Aspects	Average Score	Criterion
Supporting Theories	3,90	Valid
Model Structure	4,00	Valid
Syntax	3,91	Valid
Social System	3,87	Valid
Reaction Principle	3,84	Valid
Support System	3,81	Valid
Instructional impact and accompaniment impact	3,99	Valid
Implementation of Learning	3,89	Valid
Learning environment and task management	3,79	Valid
Evaluation	3,77	Valid
Total average score	3,87	Valid

Based on Table 5, it is concluded that the components of the EAQD-PC model have covered all aspects of learning. Expert suggestions for syntax revision to make it simpler but facilitate students' metacognition training. Along with the revision of the model syntax, the language was simplified to make it easier for students to understand. In conclusion, EAQD-PC is valid and can be applied in classroom learning. All model instruments (SAP, and MFI) were also declared valid with a score of 3.58 and 3.58 and 3.87, respectively. The validity of the lecturer and student questionnaires is also confirmed to be valid.

3.2.3. Instrument Validation Results

The metacognitive skills test consists of 15 essay questions on Plant Physiology. The validation test results include a valid instrument (10 questions) with a score of 0.329 - 0.679 as seen in appendix A and the instrument can be seen in appendix B. reliability test also denotes a reliable instrument with a value of r = 0.548.

3.3. Assessment Stage

3.3.1. Practicality of EAQD-PC Learning Model

Model practicality data consists of the effectiveness of the model and the practicality of the learning process using the EAQD-PC model.

1. Practicality of EAQD-PC Components

The results of the feasibility test in terms of the practicality of the model components consisting of the EAQD-PC syntax, social system, reaction principle, and support system can be seen in Table 6.

Table 6. Feasibility of EAQD-PC Components

Meeting No.	Feasibility of EAQD-PC Model Components				
	Syntax	Social System	Reaction Principle	Support System	Average
1	4,47	4,11	4,00	4,39	4,24
2	4,49	4,09	4,01	4,42	4,25
3	4,54	4,14	4,36	4,53	4,39
4	4,58	4,21	4,69	4,55	4,59
5	4,65	4,25	4,71	4,67	4,64
6	4,69	4,26	4,68	4,59	4,55
7	4,76	4,27	4,73	4,71	4,47
8	4,78	4,45	4,75	4,85	4,65
9	4,79	4,47	4,81	4,76	4,67
10	4,81	4,55	4,80	4,38	4,66
11	4,89	4,59	4,81	4,75	4,76
Average score	4,4,67	4,30	4,57	4,60	4,53

Table 6 illustrates that the EAQD-PC component scored 4.53 in terms of practicality which suggests that the EAQD-PC learning model is feasible because it is practical.

2. Practicality EAQD-PC Model Syntax

The results of observations into the practical implementation of EAQD-PC can be seen in Table 7.

Table 7. Practicality of EAQD-PC syntax

No.	*Exploring*	*Analyzing*	*Questioning*	*Defining*	*Peer Coaching*	Average
1	4,29	4,39	4,49	4,09	4,59	4,54
2	4,31	4,31	4,83	4,15	4,58	4,47
3	4,42	4,72	4,53	4,27	4,59	4,51
4	4,48	4,61	4,51	4,39	4,68	4,54
5	4,57	4,62	4,58	4,37	4,81	4,59
6	4,58	4,61	4,73	4,49	4,79	4,64
7	4,56	4,52	4,75	4,51	4,78	4,61
8	4,69	4,49	4,60	4,53	4,82	4,63
9	4,68	4,49	4,78	4,29	4,79	4,57
10	4,72	4,45	4,72	4,36	4,81	4,66
11	4,73	4,36	4,69	4,67	4,71	4,68
Average	4,55	4,50	4,65	4,39	4,69	4,57

Table 7 illustrates that the mean scores obtained at each meeting are different. Even though there was a decrease at the 7th meeting. The total average score of syntax feasibility was 4.57. This proves that the EAQD-PC syntax is practical.

3.3.2 Effectiveness of the EAQD-PC Learning Model

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 22 December 2022 doi:10.20944/preprints202212.0430.v1

The effectiveness of the EAQD-PC model data was obtained through the homogeneity test of metacognition skills tests, the implementation of EAQD-PC. The test results show that the students' post-test mean scores are higher than the pretest scores shown in the Table 8.

Table.8 Ancova Test Result

Learning model	Mean Score		N-Gain	category
	Pretest	Post-Test		
EAQD-PC	46.77	88.46	0.50	Medium

Table 8 shows that students experienced an increase in metacognitive skills by 41.69% after participating in learning with the EAQD-PC model. The student's N-gain score is in the moderate category (0.50). That, illustrates that EAQD-PC can effectively improve students' metacognitive skills.

The effectiveness of EAQD-PC is also evidenced by the positive questionnaire of lecturers and students on the syntax of the EAQD-PC model. The average student response score was 3.36 and the average lecturer response score was 4.97 for syntax, 4. 98 for social systems, 4.90 for reaction principles, 4.95 for support systems, and for impact instructional 5.00, as well as 4.93 for accompaniment impact. This data shows that the responses of students and lecturers is positive to the EAQD-PC learning model.

4. Discussion

The results of the study prove that EAQD-PC is valid, effective, and practical in training students' metacognitive skills with the medium n-gain category. The results of the analysis of data questionnaire responses of students and lecturers on EAQD-PC were positive. These findings suggest that the EAQD-PC can be a medium for learning discovery through exploring (investigating and searching) content. Students' metacognitive skills scores increased after going through training learning facilitated by the EAQD-PC model. The discovery learning experience is facilitated with a learning model syntax based on metacognition strategies at each stage (exploring, analyzing, questioning, defining, and peer coaching).

The first stage of exploration: students learn to explore or dig deeper into the content by investing time to learn repeatedly which ultimately explores to learn to discover. Discovery arises from the accumulation of learning experiences and this supports the development of their ability to learn independently [44], [45]. Because the best learning is through doing and actively exploring [46], [47]. Bruner states that children who are able to actively solve problems are also capable of exploring [48]. This activity is expected to become a habit and daily classroom culture [8] to always explorative in reading [49], [50] using metacognitive strategies [51]. The construction of knowledge gained in the exploration process is guided by cognitive strategies and metacognitive strategies (self-questioning) so that it is no longer monotonous when reading [52], [53]. For example, a student may have knowledge about the importance of water for plants (declarative), but have difficulty in helping plants prevent the transpiration process from occurring in a excessive (procedural knowledge) [44]. Self-monitoring in exploration requires critical thinking [11] and reflective thinking to become independent learners [19] [29] The exploration stage aims to build their knowledge through reading with metacognitive controls [54]. Thus, through this stage of exploration, students are trained to no longer be monotonous when reading.

Secondly, analyze, at this stage students are trained to learn to analyze. Then analyze to learn to understand the meaning of reading. Content lives in the form of thinking and dies when one reads it without analyzing or thinking [55], [56] Because reading is understanding the meaning of what is read [54] This process of analyzing not only aims to check understanding [49], [57] but also to check the correctness of the achievement of

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 22 December 2022 doi:10.20944/preprints202212.0430.v1

understanding [58], [59] In this process, students are stimulated to ask themselves how far they understand the content they are exploring.

Third, *the questioning* stage, this stage is integrated into all stages. Therefore, this stage has a dual role, firstly as a cognitive strategy to achieve understanding of the text in exploring and analyzing the content; second, as a metacognitive strategy to control and develop the achievement of cognitive goals [18], [60] *Self-questioning* is an important aspect of metacognitive skills for students to address comprehension problems in exploratory learning – such as: What is my previous knowledge that can help me understand this content? Self-questioning is referred to as a personal attribute skill that is useful for encouraging students to learn better [61] The practice of exploring lessons through this questioning stage gives students two advantages; First, they become possessed of learning skills to learn, skillfully wondering-for example: What is effective in making it? Why is that? How is the process going? etc; secondly, cognitive intelligence and their metacognitive intelligence develop together.

Fourth, *Defining* stage (D) Learning exercises from the first stage to the third stage. The three stages of this model provide some accumulated learning experiences for learning. Students who were initially unfamiliar with this learning model, but by continuing to practice learning to explore, learn to analyze and learn to ask one, two, three times, finally they understand and realize that they have learned effectively as a result of accumulated experience from practice after practice. The accumulation of these exercises gives them an understanding of the content in order to form a new understanding of the material they are studying. This can be achieved through the selection of self-regulatory strategies in effective learning [62] The understanding that has been gained allows students to redefinition to provide editorial and new understanding of the information received from subject matter. This is where the importance of metacognitive strategies in learning comes in. So, this EAQD-PC class is a student development laboratory - as John Dewey said that schools are stress-free human development laboratories [63] where students are free to explore. Mistakes or failures are only seen as part of the learning process, not offenses or crimes that should be punished.

Fifth, peer coaching (PC), at this stage students learn to become coaches and then become coaches to learn. This stage is a reflection of all stages of the EAQD-PC model that has been carried out by students. Here, in conducting peer coaching, students' personal and social metacognitive intelligence is honed to become skilled in collaborating [64], [3]. Ladyshewsky [65]) claims that peer coach (PC) is one of the experiential learning techniques that allows to add depth to student learning. This experience is expected to encourage students to become active learners independently throughout their lives. Findings from several studies prove that peer coaching facilitates effective learning [67], [68] significantly improves student learning success [69], [70] The application of peer coaching (PC) can be done in early childhood – as Sharon did in Donegan [71] has managed to help children with disabilities change in a positive direction. Individuals as social beings always need support from various parties, such as colleagues, classmates to develop themselves, build self-confidence with the support of friends. Self-confidence facilitates self-regulation and active and independent learning throughout life [72] Peer coaching is a very effective approach [66] and has the potential to encourage collaborative interaction between students through mutual coaches to reflect on the results of their exploration.

Based on this previous description, it shows that the EAQD-PC model developed that integrates metacognition training into the learning curriculum as a form of intervention that has the potential to improve student metacognition. Researchers expect biology education students to have metacognitive awareness and skills so that they become independent learners. The results of this study are expected to provide information to readers who want to conduct relevant research.

5. Conclusion

The results of this study found that the metacognition skills of Biology Education students of Muhammadiyah Bone University are generally in the medium category, very few are in the high category, but, also only a few in the low category. Analysis of the learning curriculum shows that lecturers have not integrated their learning with metacognition training. The learning process in higher education really needs to be integrated with metacognitive skills training to improve students' metacognitive skills. Learning interventions through innovative approaches that encourage learning responsibility to become a burden and responsibility for students independently. Learning interventions are needed to train and improve students' metacognition skills. This model also increases students' academic success in terms of mastery of content. The EAQD-PC learning model developed in this study has proven to be valid, practical, and effective for use to train students' metacognition skills.

The validators stated EAQD-PC was valid content, syntax, social system, support system, and learning impact. This model is also declared feasible and practical for training and improving the metacognitive skills of students. Thus, EAQD-PC is recommended to train students' metacognitive skills in all fields of science. Therefore, the entire EAQD-PC syntax and social system is a simple and practical metacognition strategy that is easy to apply to all fields of science and all age levels.

Author Contributions: conceptualization, N., H.S., I., S; formal analysis, N and H.S.; methodology, N., H.S., and I; writing -original draft, N. and H.S.; writing-review and editing, N., H.S., I., and S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Ethical review and approval were waived for this study, due to reason that all students had agreed to participate in this study.

Informed Consent Statement: All learning processes and data collection complies with the local legislation and institutional requirements. All of the participants stated their informed consent to participate in the study and no individual information was published. Thus, the ethical approval was waived.

Data Availability Statement: All the data in this study were available.

Acknowledgments

I would like to thank the Indonesian Ministry of Research, Technology and Higher Education (kemenristekdikti) for providing a doctoral education scholarship (S3) for Biology Education, State University of Malang based on the decree, number 2903.24 / D3 / PG / 2017.

Conflicts of Interest: The authors declare no conflict of interest. The funders did not take any part in the study's design; the collection, analyses, or interpretation of data; the writing of the manuscript, or the decision to publish the results.

Appendix A

Instrument Validity Test Results

Table A Instrument Validity test results

Items	**Pearson Correlation**	**Sig. (2-Tiled)**	**Remark**
Number 1	0.227	0.398	Invalid
Number 2	0.679	0.003	Valid
Number 3	0.387	0.001	valid
Number 4	0.323	0.058	Invalid
Number 5	0.590	0.000	Valid
Number 6	0.329	0.023	Valid
Number 7	0.041	0.598	Invalid
Number 8	0.671	0.002	Valid
Number 9	0.435	0.087	Invalid
Number 10	0.329	0.047	Valid
Number 11	0.604	0.002	Valid
Number 12	0.043	0.417	Invalid
Number 13	0.469	0.000	Valid
Number 14	0.483	0.003	Valid
Number 15	0.578	0.000	Valid

Appendix B Metacognitive Skills Test Instrument

1. Water has two properties, physical properties and chemical properties. Understand the concept of water potential in relation to the chemical potential of water. What do you think is the relationship between the two so that it can help you understand the movement of water in the plant body? Describe your explanation!
2. Indah observed two different tomato plant trees and looked for factors causing the difference. After searching for explanations from various sources from found that a fertile tomato plant is precisely because it is infected with fungi on its roots. Why do you think it is precisely the infected at the root? Elaborate on your explanation of the role of the fungus!
3. Optimal growth in plants is supported by the completeness of the types of nutrients needed. Try to observe the leaves of plants in the garden, some are perfect in color and shape, some are not! The classification of nutrients is divided into two. Give an explanation of the function of both types of classification to optimal planting growth so that the color and shape of the leaves are perfect from the results of your exploration of both!
4. Plants in their lives cook their own food which we know by the term photosynthesis. The process of photosynthesis is known as oxygenic and anoxygenic photosynthesis. What do you think is the evolutionary role of oxygenic photosynthesis against photosynthetic organisms?
5. Andi thinks that the distribution of photo-assimilate occurs day and night or every time. After he sought explanations from articles and other learning resources, he became aware of when the distribution of photo-assimilate occurred. What do you think is the name of the distribution process and when does it occur?
6. When Yuli observed plants, he divided plants into two based on their respiratory system and compared the two systems so that he concluded that plants that breathe using oxygen are larger while plants that breathe without using oxygen are generally smaller. Would you be able to shed some light on the relationship between that and respiration?
7. Nitrogen is the most macronutrient in plants. In the process of the nitrogen cycle is known the process of ammonification, nitrification, and denitrification. According to the results of your exploration what are the three processes related to the nitrogen cycle?

8. The discussion of water and plants is not only related to photosynthesis but also concerns injuries or injuries due to water. The surrounding environment of flooded plants can be a threat to plants. Explain how water can hurt plants!
9. Plants just like animals and humans will face sudden changes from optimal conditions for growth to some suboptimal abiotic conditions known as extreme conditions, such as high light, high or low temperatures and water shortages. This condition disrupts the physiological functioning of plants. How does a plant maintain its viability in extreme conditions?
10. Fikri observed the growth and development of plants as complex multicellular organisms. To that end he explored information about how cells coordinate with each other, and he found that regular intercellular communication requires extraordinary measurements and that is done with the help of hormones. How do you think hormones do that?

Referensi

[1] AACTE & P21, "Teachers for the 21st Century," *Education*, no. September, pp. 22–29, 2013, [Online]. Available: http://www.oecd-ilibrary.org/education/teachers-for-the-21st-century_9789264193864-en [Crossref]

[2] AACTE & P21, "Partnership for 21st Century Student Outcomes," pp. 1–9, 2015, [Online]. Available: http://www.p21.org/our-work/p21-framework

[3] C. P. Dwyer, M. J. Hogan, and I. Stewart, "An integrated critical thinking framework for the 21st century. Thinking Skills and Creativity. volume 12. page 43-52. 2014.," *Think. Ski. Creat.*, vol. 12, pp. 43–52, 2014, doi: 10.1016/j.tsc.2013.12.004. [Crossref]

[4] R. Adiansyah., C. A.D, Z. S, and R. F., "The correlation between metacognitive skills and scientific attitudes towards the retention of male and female students in South Sulawesi, Indonesia," *Int. J. Eval. Res. Educ.*, vol. 10, no. 4, p. 1272, 2021, doi: 10.11591/ijere.v10i4.21597. [Crossref]

[5] S. Saenab, S. Zubaidah, S. Mahanal, and S. R. Lestari, "education sciences ReCODE to Re-Code : An Instructional Model to Accelerate Students ' Critical Thinking Skills," 2021. [Crossref]

[6] L. D. Frazier, B. L. Schwartz, and J. Metcalfe, "The MAPS model of self-regulation: Integrating metacognition, agency, and possible selves," *Metacognition Learn.*, vol. 16, no. 2, pp. 297–318, 2021, doi: 10.1007/s11409-020-09255-3. [Crossref]

[7] W. Saputri, "Keterampilan Metakognitif Mahasiswa Calon Guru dan Hubungannya dengan Pola Pembelajaran Dosen ," *Didakt. Biol. J. Penelit. Pendidik. Biol.*, vol. 1, no. 2, pp. 113–121, 2017, [Online]. Available: http://jurnal.um-palembang.ac.id/index.php/dikbio [Crossref]

[8] Tanner K. D., "Promoting student metacognition.," *CBE Life Sci. Educ.*, vol. 11, no. 2, pp. 113–120, 2012, doi: 10.1187/cbe.12-03-0033. [Crossref]

[9] Kwok S., "Science Education in the 21 st Century," *Submitt. to Nat. Astron.*, 2018. [Crossref]

[10] N. S. Afandi, Sajidan, M. Akhyar, "Development Frameworks of the Indonesian Partnership 21st-Century Skills Standards for Prospective Science Teachers: A Delphi Study," vol. 8, no. 1, pp. 89–100, 2019, doi: 10.15294/jpii.v8i1.11647. [Crossref]

[11] A. K. D. M. A. Quigley, "Metacognition and Self-regulated Learning: Guidance Report," *Sutt. Trust. Endow. Found. Teach. Learn. Toolkit*, pp. 1–30, 2018, [Online]. Available: [Crossref]

[12] Dilek Sezgin Memnun and Recai Akkaya, "The levels of metacognitive awareness of primary teacher trainees," *Procedia - Soc. Behav. Sci.*, vol. 1, no. 1, pp. 1919–1923, 2009, doi: 10.1016/j.sbspro.2009.01.337. [Crossref]

[13] Tajularipin Sulaiman; Suzieleez Syrene Abdul Rahim; Wong Kai Yan; Punnithann Subramaniam, "Primary science teachers' perspectives about metacognition in science teaching," *Eur. J. Educ. Res.*, vol. 10, no. 1, pp. 75–84, 2021, doi: 10.12973/EU-JER.10.1.75. [Crossref]

[14] B. C. Buckley and E. S. Quellmalz, "Supporting and Assessing Complex Biology Learning with Computer-Based Simulations and Representations," *Mult. Represent. Biol. Educ. Ser. Model. Model. Sci. Educ.*, vol. 7, pp. 19–38, 2013, doi: 10.1007/978-94-007-4192-8. [Crossref]

[15] M. S. Doğru and L. C. Özsevgeç, "Biology Subjects Which the Teacher Candidates Have Difficulties in Learning and Leading Reasons,"

Online Submiss., vol. 5, no. 5, pp. 221–232, 2018, doi: 10.5281/zenodo.1479932.[Crossref]

[16] A. Widowati, S. Nurohman, and P. Anjarsari, "Developing science learning material with authentic inquiry learning approach to improve problem solving and scientific attitude," *J. Pendidik. IPA Indones.*, vol. 6, no. 1, pp. 32–40, 2017, doi: 10.15294/jpii.v6i1.4851. [Crossref]

[17] T. J. Ertmer, P. A., & Newby, "The expert learner: Strategic, self-regulated, and reflective," *Instr. Sci.*, vol. 24, no. 1, pp. 1–24, 1996, doi: 10.1007/BF00156001. [Crossref]

[18] Y. Pantiwati and Husamah, "Self and peer assessments in active learning model to increase metacognitive awareness and cognitive abilities," *Int. J. Instr.*, vol. 10, no. 4, pp. 185–202, 2017, doi: 10.12973/iji.2017.10411a. [Crossref]

[19] John Biggs and Catherine Tang, *Teaching For Quality Learning At University Fourt Edition*, vol. 2011. New York: Society for Research into Higher Education & Open Universty Press, 2011. [Online]. Available: http://books.google.se/books/about/Teaching_for_Quality_Learning_at_Univers.html?id=XhjRBrDAESkC&pgis=1 [Crossref]

[20] C. Y. Colbert *et al.*, "Teaching Metacognitive Skills: Helping your Physician Trainees in the Quest to 'Know What They Don't Know,'" *Am. J. Med.*, vol. 128, no. 3, pp. 318–324, 2014, doi: 10.1016/j.amjmed.2014.11.001. [Crossref]

[21] G. Stephanou and M.-H. Mpiontini, "Metacognitive Knowledge and Metacognitive Regulation in Self-Regulatory Learning Style, and in Its Effects on Performance Expectation and Subsequent Performance across Diverse School Subjects," *Psychology*, vol. 08, no. 12, pp. 1941–1975, 2017, doi: 10.4236/psych.2017.812125. [Crossref]

[22] J. Perry, D. Lundie, and G. Golder, "Metacognition in schools: what does the literature suggest about the effectiveness of teaching metacognition in schools?," *Educ. Rev.*, vol. 71, no. 4, pp. 483–500, 2018, doi: 10.1080/00131911.2018.1441127. [Crossref]

[23] Marcel V. J. Veenman, B. H. A. M. Van Hout-Wolters, and P. Afflerbac, "Metacognition and learning: Conceptual and methodological considerations. 08 March 2006," *Metacognition Learn.*, vol. 1, no. 1, pp. 3–14, 2006, doi: 10.1007/s11409-006-6893-0. [Crossref]

[24] G. Schraw and D. Moshman, "Metacognitive Theories," 1995. [Crossref]

[25] T. Djudin, "Preparing A Strategic Learner By Using Metacognitive Strategies: From Theory Into Practice," *J. Educ. Learn.*, vol. 12, no. 3, pp. 501–509, 2018, doi: 10.11591/edulearn.v12i3.7208. [Crossref]

[26] S. Moutinho, J. Torres, I. Fernandes, and C. Vasconcelos, "Problem-Based Learning And Nature of Science: A Study With Science Teachers," *Procedia - Soc. Behav. Sci.*, vol. 191, pp. 1871–1875, 2015, doi: 10.1016/j.sbspro.2015.04.324. [Crossref]

[27] D. J. Treffinger, G. C. Young, E. C. Selby, and C. Shepardson, *Assessing Creativity: A Guide for Educators*, no. December. 2002. [Online]. Available: http://www.eric.ed.gov/ERICWebPortal/detail?accno=ED505548 [Crossref]

[28] S. Shye and I. Yuhas, "Creativity in problem solving," *Isr. Sci. Found.*, no. January 2004, 2004, doi: 10.13140/2.1.1940.0643. [Crossref]

[29] A. M. S. Muhittin Çalişkan, "Muhittin Çalişkan, Ali Murat Sünbül, The effects of learning strategies instruction on metacognitive knowledge, using metacognitive skills and academic achievement (Primary education sixth grade Turkish course Sample)," *Kuram ve Uygulamada Egitim Bilimleri*, vol. 11, no. 1. pp. 148–153, 2011. [Crossref]

[30] C. Kidd and B. Y. Hayden, "Perspective The Psychology and Neuroscience of Curiosity," *Neuron*, vol. 88, no. 3, pp. 449–460, 2015, doi: 10.1016/j.neuron.2015.09.010. [Crossref]

[31] P. Tough, *How Children Succeed: Grit, Curiosity, and the Hidden Power of Character*. 2012.

[32] C. Von Colln-Appling and D. Giuliano, "A concept analysis of critical thinking: A guide for nurse educators," *Nurse Educ. Today*, vol. 49, pp. 106–109, 2017, doi: 10.1016/j.nedt.2016.11.007. [Crossref]

[33] D. Kelly, *The Art of Reasoning*, vol. 12, no. 3. 2013. doi: 10.5840/teachphil198912370. [Crossref]

[34] Susan E. Israel, C. C. Block, K. L. Bauserman, and K. Kinnucan-Welsch, *Metacognition in Literacy Learning. Theory, Assessment, Instruction, and Professional Development*. 2005. [Crossref]

[35] John H. Flavell, "Metacognition and Cognitive Monitoring: A New Area of Cognitive-Developmental Inquiry. American Pschologyst October 1979 Vol. 34, No. 10,906-911," *Am. Psychol.*, vol. 34, no. 10, pp. 906–911, 1979. [Crossref]

[36] Gholam-Reza Abbasian and M. K. Esmailee, "Peer- Coaching, EFL Teacher's Professional Identity Development and Students' Academic Achievements," *Theory Pract. Lang. Stud.*, vol. 8, no. 1, p. 150, 2018, doi: 10.17507/tpls.0801.19. [Crossref]

[37] M. R. Ahmadi and A. P. Gilakjani, "Reciprocal teaching strategies and their impacts on English reading comprehension," *Theory Pract.*

Lang. Stud., vol. 2, no. 10, pp. 2053–2060, 2012, doi: 10.4304/tpls.2.10.2053-2060. [Crossref]

[38] T. Plomp, N. Nieveen, J. van den Akker, B. Bannan, and A. Kelly, "Educational Design Research: An Introduction," *Educ. Des. Res.*, p. 204, 2013, doi: 10.1007/978-1-4614-3185-5_11. [Crossref]

[39] Nurdin, "Model Pembelajaran Matematika yang Menumbuhkan Kemampuan Metakognitif untuk Menguasai Bahan Ajar," no. Disertasi tidak diterbitkan. Surabaya: PPs Universitas, 2007.

[40] R. S. Schraw, Gregory Dennison, "Assessing metacognitive awareness," *Contemporary Educational Psychology*, vol. 19, no. 4. pp. 460–475, 1994. doi: 10.1006/ceps.1994.1033. [Crossref]

[41] Sugiyono, *Metode Penelitian Pendidikan Pendekatan Kuantitatif, kualitatif, dan R&D.* Bandung: Alfabeta, 2010.

[42] D. P. Ausubel, "The facilitation of meaningful verbal learning in the classroom," *Educ. Psychol.*, vol. 12, no. 2, pp. 162–178, 1977, doi: 10.1080/00461527709529171. [Crossref]

[43] Paul. D, "Learning Theory Ausubel's Learning Theory. http://fpmipa.upi.edu/data/report_activity/9875881844.pdf. 1-17," *Univ. Pendidik. Indones.*, pp. 1–17, 2012,

[44] Steffen Moritz and P. H.Lysaker, "Metacognition – What did James H. Flavell really say and the implications for the conceptualization and design of metacognitive interventions," *Schizophr. Res.*, vol. 201, pp. 20–26, 2018, doi: 10.1016/j.schres.2018.06.001. [Crossref]

[45] J. Biggs, "The Role of Metacognition in Enhancing Learning. Australian Journal of Education, 32(2), 127–138. doi:10.1177/000494418803200201," *Aust. J. Educ.*, vol. 32, no. 2, pp. 127–138, 1988, doi: 10.1177/000494418803200201. [Crossref]

[46] Brian Critchley, "Critical Thinking in Business Education," *Investig. Univ. Teach. Learn.*, vol. 7, no. 1995, pp. 5–15, 2011. [Croosref]

[47] Soul McLeod, "Jean Piaget ' s Theory of Cognitive Development. Background and Key Concepts of Piaget's Theory. Available online: Simply Psychology. www.simplypsychology.org/piaget.html. (accessed on 09 Februari 2021)," *Simply Psychology*, no. 1936. 2018.

[48] M. K. Smith, "Jerome S. Bruner and the process of education," *Encycl. Informal Educ.*, pp. 5–10, 2002.

[49] E. Henning, "Reading as learning in the primary school," *South African J. Child. Educ.*, vol. 6, no. 1, p. 6, 2016, doi: 10.4102/sajce.v6i1.504. [Crossref]

[50] Susan Israel, *Using Metacognitive Assessments to Create Individualized Reading Instruction*. 2007. [Crossref]

[51] Paul R. Pintrich, "The Role of Metacognitive Knowledge in Learning , Teaching , and Assessing. 17 Oct 2017," *Theory Pract.*, vol. 41, no. 906706830, pp. 219–225, 2002. [Crossref]

[52] Dale H. Schunk, *Learning Theories An Educational Perspective Sixth Edition. Pearson Education, Inc., publishing as Allyn & Bacon, 501 Boylston Street, Boston, MA, 02116. Volume 322. issue 6078. page 39*, vol. 322, no. 6078. 2012. doi: 10.1038/322399b0. [Crossref]

[53] Santrock J.W, *Educational Psychology; Sixth Edition. University of Texas at Dallas. Published by McGraw-Hill Education, 2 Penn Plaza, New York, NY 10121. by McGraw-Hill Education. 1-678. e-book.*, Sixth Edit. New York: McGraw-Hill Education, 2018.

[54] L. Baker and A. L. Brown, "Metacognitive skills and reading-Technical Report," *Handb. Read. Res.*, pp. 353–394, 2016. [Crossref]

[55] E. Ellianawati and H. D. B. Subali, S. N. Khotimah, M. Cholila, "Face-to-Face Mode vs. ONLINE Mode: A Discrepancy in Analogy-Based Learning During Covid-19 Pandemic," *J. Pendidik. IPA Indones.*, vol. 10, no. 3, pp. 368–377, 2021, doi: 10.15294/jpii.v10i3.30037. [Crossref]

[56] K. Celuch and M. Slama, "Teaching Critical Thinking Skills for the 21 st Century : An Advertising Principles Case Study," no. October 2014, pp. 37–41, 2010, doi: 10.1080/08832329909601675. [Crossref]

[57] Yusnaeni, A. D. Corebima, H. Susilo, and S. Zubaidah, "Creative thinking of low academic student undergoing search solve create and share learning integrated with metacognitive strategy," *Int. J. Instr.*, vol. 10, no. 2, pp. 245–262, 2017, doi: 10.12973/iji.2017.10216a. [Crossref]

[58] S. Amin, Astuti M. Aloysius D, Corebima, Siti Zubaedah, , Mahanal, "The Correlation between Metacognitive Skills and Critical Thinking Skills at the Implementation of Four Different Learning Strategies in Animal Physiology Lectures," *Eur. J. Educ. Res.*, vol. 9, no. 1, pp. 143–163, 2019, doi: 10.12973/eu-jer.9.1.143. [crossref]

[59] N. Nurlaila and L. Lufri, "The effect of guided inquiry learning models using the help of student activity sheet on the knowledge competency of students in class xi of SMAN 1 Sungayang," *J. Phys. Conf. Ser.*, vol. 1940, no. 1, 2021, doi: 10.1088/1742-

6596/1940/1/012120. [Crossref]

[60] T. Graham and G. Schraw, “Helping gifted students develop metacognitive awareness,” *Roeper Rev.*, vol. 20, no. 1, pp. 4–8, 1997, doi: 10.1080/02783199709553842. [Crossref]

[61] S. I. Dahiru Sale Mohammed, “Conceptual model for the integration of personal attribute skills in electrical technology education curriculum,” *Int. J. Eval. Res. Educ.*, vol. 8, no. 4, pp. 705–712, 2019, doi: 10.11591/ijere.v8i4.20301. [Crossref]

[62] M. P. Fathima, N. Sasikumar, and M. P. Roja, “Enhancing Teaching Competency of Graduate Teacher Trainees through Metacognitive Intervention Strategies,” *Am. J. Appl. Psychol.*, vol. 2, no. 1, pp. 27–32, 2014, doi: 10.12691/ajap-2-1-5. [Crossref]

[63] John Dewey, *Experience and Education (Touchstone). The Kappa Delta Pi Lecture Serie. A Touchstone Book Published by Simon & Schuster Copyright O 1938 by Kappa Delta Pi. ISBN 0-684-83828-1. page 96, 1938*. Kappa Delta Pi, 1938. [Crossref]

[64] P. J. S. van Tryon and C. S. Schwartz, “A Pre-service Teacher Training Model with Instructional Technology Graduate Students as Peer Coaches to Elementary Pre-service Teachers,” *TechTrends*, vol. 56, no. 6, pp. 31–36, 2012, doi: 10.1007/s11528-012-0611-3. [Crossref]

[65] R. K. Ladyshewsky, “Peer coaching: A constructivist methodology for enhancing critical thinking in postgraduate business education. Higher Education Research and Development, vol. 25. issue. 1. page 67-84, 2006,” *High. Educ. Res. Dev.*, vol. 25, no. 1, pp. 67–84, 2006, doi: 10.1080/13600800500453196. [Crossref]

[66] Steve Sider, “Peer coaching in a school in Cairo, Egypt: Implementation, barriers, and pathways to effective adoption,” *Int. J. Mentor. Coach. Educ.*, vol. 8, no. 1, pp. 37–51, 2019, doi: 10.1108/IJMCE-04-2018-0016. [Crossref]

[67] K. A. Kohler, Frank W. McCullough, Kerry M. Buchan, “Using Peer Coaching to Enhance Preschool Teachers’ Development and Refinement of Classroom Activities,” *Early Educ. Dev.*, vol. 6, no. 3, pp. 215–239, 1995, doi: 10.1207/s15566935eed0603_2. [Crossref]

[68] F. W. Kohler, K. M. C. Crilley, D. D. Shearer, and G. Good, “Effects of peer coaching on teacher and student outcomes,” *J. Educ. Res.*, vol. 90, no. 4, pp. 240–250, 1997, doi: 10.1080/00220671.1997.10544578. [Crossrf]

[69] N. Akhavan and S. Tracz, “The Success for All Reading Program and Effect on Student Achievement in a South Central Texas Major Suburban School District,” *J. Educ. Hum. Dev.*, vol. 5, no. 3, pp. 38–53, 2016, doi: 10.15640/jehd.v5n3a5. [Crossref]

[70] den B. p. Thurlings, “Student teachers’ and in-service teachers’ peer learning: a realist synthesis,” *Educ. Res. Eval.*, vol. 24, no. 1–2, pp. 13–50, 2018, doi: 10.1080/13803611.2018.1509719. [Crossref]

[71] S. A. F. Mary M. Donegan, Michaelene M. Ostrosky, “Peer Coaching: Tachers Supporting Teachers. Young Exceptional Children,” vol. 3, no. 3, pp. 9–16, 2012.[Crossref]

[72] R. C. Zwart, T. Wubbels, T. Bergen, and S. Bolhuis, “Rosanne C. Zwart, Theo Wubbels, Theo Bergen, Sannke Bolhuis, 2009. Which characteristics of a reciprocal peer coaching context affect teacher learning as perceived by teachers and their student,” *J. Teach. Educ.*, vol. 60, no. 3, pp. 243–257, 2009, doi: 10.1177/0022487109336968. [Crossref]