Guided Inquiry Facilitated Blended Learning to Improve Metacognitive and Learning Outcome of High School Students

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Abstract. The learning activities that involve the students to learn actively is one of the characteristics of a qualified education. The learning strategy that involves students’ active learning is guided inquiry. Learning problems today are growing metacognitive skills and cognitive learning outcomes. It is the research and development of learning module by using 4D models of Thiagarajan. The first phase is Define, which analyses the problems and needs required by the prior preparation of the module. The second phase is Design, which formulates learning design and devices to obtain the initial draft of learning modules. The third stage is Develop, which is developing and writing module, module validation, product testing, revision, and the resulting an end-product results module development. The fourth stage is Disseminate, which is disseminating of the valid products. Modules were validated by education experts, practitioners, subject matter experts, and expert of online media. The results of the validation module indicated that the module was valid and could be used in teaching and learning. In the validation phase of testing methods, we used experiments to know the difference of metacognitive skills and learning outcomes between the control group and experimental group. The experimental design was a one group pretest-posttest design. The results of the data analysis showed that the modules could enhance metacognitive skills and learning outcomes. The advantages of this module is as follows, 1) module is accompanied by a video link on a website that contains practical activities that are appropriate to Curriculum 2013, 2) module is accompanied by a video link on a website that contains about manual laboratory activities that will be used in the classroom face-to-face, so that students are ready when doing laboratory activities, 3) this module can be online through chat to increase students' understanding. The disadvantages of this module are the material presented in the modules is limited. It is suggested that for the better utilisation of the online activities, students should be present at every meeting of the activities, so as to make all the students participate actively. It is also suggested that school set up facilities to support blended learning.

1. Introduction
Learning activities should involve students to think actively and act. The activeness of the students in learning is one of the factors affecting the success of learning. The Partnership for 21st Century Skills has identified metacognitive as one of the life and career skills necessary to prepare students for post-secondary education and the workforce [1]. Metacognitive skill is one dimension that is emphasised in the school curriculum [2].

Metacognition is someone’s awareness about his thinking process. In other words, metacognition is typically characterised by monitoring and regulating their thinking processes to produce an effective process for himself [3]. Metacognition can simply be defined as thinking critically about what the people think, or thinking about thinking [4].
Metacognition involves tasks, strategies, and cognition of oneself [2]. The strategy refers to the process of thinking, completing tasks using their cognition. Metacognition is the awareness of thinking to understand, monitor, about what is known and what is done [5]. Students must have the metacognitive knowledge to have the metacognitive ability. Thus, the metacognitive strategy is a very critical component. In metacognition are known the terms metacognitive awareness, that is what one believes and how one knows, and metacognitive strategies which are useful for information processing [6].

Tanner [7] states metacognition is knowledge about one's learning or knowing how to learn and monitoring one's learning behaviours to determine the degree of progress and strategies needed for accomplishing instructional goals. Based on the statement, it can be interpreted that metacognition is a person's knowledge about learning, and monitor the behaviour of their learning to determine the development and learning needed to achieve the learning objectives [8]. Metacognition is a reflective cognition, a higher order thinking process which involves active control over cognitive processes [9]. The statement means that metacognition is a form of cognition or high-level thinking processes or involving the control of the cognitive activity. Therefore, metacognitive can be regarded as a person’s thinking about his thinking, or a person’s cognition about his cognition.

Metacognition has three components for problem-solving in learning, namely: (a) metacognitive knowledge, (b) metacognitive skills, and (c) metacognitive beliefs [10]. However, the most common differences in metacognition are separating metacognitive knowledge from metacognitive skills. Metacognitive knowledge refers to declarative knowledge, procedural knowledge and conditional knowledge of a person on problem-solving. While metacognitive skills refer to the prediction skills, planning skills, monitoring skills, and evaluation skills.

Metacognitive skills of each are different, depending on the knowledge and experience [10]. The efforts to improve self-control in learning are as follows: a) to encourage students to select and monitor several learning objectives they expect, (b) to provide the opportunity for students to learn and perform optimally without any pressure from outside, (c) to provide the opportunity for students to do activities that involve their learning goals, management strategies and learning time, d) to help complete the learning equipment needed, e) to provide the opportunity for students to think critically and to provide feedback on their efforts, f) to ask the students to evaluate the results that have been obtained, whether or not the results are suitable for the objectives and the standards that have been set [1].

The research showed that the Indonesian students’ metacognitive ability was still low, both of the elementary school students [11] and the high school students [12]. The research results showed that low levels of metacognitive skills had an effect on the low learning results. The results of the observation on the level of the activeness of the students in Public Senior High School 1 Malang were quite low. It could be seen when the teacher gave the students questions. Learning problems that the students had been such as, 70.97% of 35 students found it difficult to learn biology because of the confusing scientific terms in the textbooks, and 83.87% of the students said that biology lessons were tedious because a lot of biology material required memorization learning. It was one of the causes that the students had not reached the KKM (the minimum passing grade). Also, 48.39% of the students did not realise the importance of learning biology for themselves, so that the students felt lazy to learn biology deeper. The results of the interview showed that the students had not been able to connect the biological concepts with their real life so that the students had not realised the importance of learning biology. The low awareness of the students showed that the students’ metacognitive skills needed to be improved.

Metacognitive skills determine the learning results. Metacognitive skills are related to thinking how to think, knowing what is known and the unknown, so that it is useful for problem-solving [13]. These metacognitive skills are required to understand a concept so that the concept gained by students is better because it is gained through a process which involves metacognitive skills.

Metacognitive skills and metacognitive strategies can be learned [14]. Therefore, it is necessary to find learning strategies that improve metacognition. In recent years, research has been conducted to investigate the inquiry-based learning in supporting metacognitive skill development [15].

Inquiry and experimentation learning fosters metacognition and scientific reasoning [16]. The inquiry with questions will direct the learning in an inquiry climate that fosters self-dependency in
The research population consisted of five classes of the second year students in academic year 2013/2014 as many as 165 students. The total number of the students in the control class was 35 students. The number of the students in the experimental class (GiqBL) was 35 students, and the total number of the students in the control class was 35 students.

Before the research was conducted, the researcher developed a lesson plan, modules, and worksheets. The module about circulatory system consisted of two topics, namely the components of mastering new things [17]. The inquiry is an important component in science education [18]. Biology learning in Indonesia has not yet fostered the process of inquiry in students. Guided inquiry-based learning makes students involved in learning so that learning becomes meaningful for students. The main characteristic of guided inquiry is that students are directed to search and find the concepts independently, critically, and logically. Guided inquiry learning by changing the passive learning patterns into active learning and critical learning patterns [18].

Inquiry learning has complex learning situations so that scaffolding is needed to engage students to inquire, manage investigations and solve problems; help students make sense of their thinking processes [19]. High school students are interested in using the web-based scientific resources), so that the sources on the web can be used as a scaffolding of inquiry [20]. Also, the worksheet can also be an effective scaffold in problem-solving learning [21]. Learning by utilising online computer can enhance the ability of self-explanation so that it can help learning by doing [9].

Blended learning is a learning method that combines the face-to-face session and online learning session [22]. Blended learning is also called a hybrid online [23] that combines the online digital content, multimedia training compact disks, supplemental learning content online discussions, and live broadcasting to improve the learning processes and learning outcomes [23]. In general terms, blended learning combines the online delivery of educational content with the best features of classroom interaction and live instruction to personalise learning, allow thoughtful reflection, and differentiate instruction from student to student across a diverse group of learners [24]. The virtual meetings between the teachers and learners were carried out online because they might be in two different worlds or places, but they could give feedback to each other, asked or answered questions. Long distance also calls it instructed learning or virtual instructor led training which is guided by an instructor virtually since the instructor and the student are in a different place. Regardless of the name, this learning utilises IT technology through the medium of video conferencing, phone conferencing, or chat online [25].

Metacognitive competence is needed for students. Biology learning in high schools uses scientific investigation to help students develop depth understanding of biological knowledge and problem-solving through metacognitive strategy. This research aimed at investigating the effect of guided inquiry facilitated blended learning on metacognitive skills and learning outcomes of high school students. This research was designed to test the hypothesis that the inquiry learning facilitated blended learning improves metacognition compared with inquiry learning. This research was conducted on senior high school students in the eleventh grade to prove the hypothesis.

2. Research Methodology
This research used the Research and Development approach using the 4D model [26]. The steps are as follows.
1. Define: analysing problems, and the other required needs before the drafting module.
2. Design: formulating a lesson plan as an outline/draft of learning.
3. Develop: developing and writing modules, expert appraisals, product testing, revision, and producing the final product of the module development.
4. Disseminate: spreading the products that have been developed and have been validated.

Dissemination was done using quasi-experimental approach and a nonequivalent control group pretest-posttest design [27]. This research aimed at determining the effect of guided inquiry facilitated blended learning on the empowerment of students' metacognitive skill in biology learning in senior high schools in Malang, Indonesia. The independent variables were teaching strategies consisting of guided inquiry facilitated blended learning (GiqBL) and guided inquiry (GIG). The dependent variable was students' metacognitive skill. This research was conducted in the odd semester of academic year 2013/2014.

The research was conducted at public senior high school 1 Malang, Indonesia. The research population consisted of five classes of the second year students in academic year 2013/2014 as many as 165 students. The total samples of this research were 70 students. The number of the students in the experimental class (GiqBL) was 35 students, and the total number of the students in the control class was 35 students.

Before the research was conducted, the researcher developed a lesson plan, modules, and worksheets. The module about circulatory system consisted of two topics, namely the components of
blood and blood circulation organs. Each module contains the explanation of the materials, blood circulation physiology processes and blood abnormality. The module was equipped with 1) Introduction, 2) Table of Contents, List of Tables, 3) List of Figures, 4) How to Use Module, 5) Objectives, Concept Map, 6) Topic I components of blood, 7) problems, 8) What is your hypothesis, 9) is your hypothesis correct? Find Out!, 10) Virtual Laboratory, 11) Conclude Results of the activity!, 12) Topic II blood circulation organs, 13) Material Description, 14) Feedback, 15) Summary, and 16) Competency Test.

GIqBL learning and GIQ learning were implemented for 6 weeks in different classes. The learning topics in both these strategies are blood system, lymph, and the circulation of blood and the circulation of lymph. Scientific inquiry learning used the stages/phases of learning referring to Llewellyn [28], namely exploring phenomena, formulating investigative / experimental questions, planning investigation/experiment, conducting investigation/experiment and collecting data, analysing the data and evidence, building new knowledge and communicating new knowledge. In GiqBL models, the learning materials were uploaded on the website which can be downloaded by the students. The online discussion was done online through Facebook.

All the learning materials have been reviewed by animal physiology lecturer of State University of Malang, Dr Abdul Ghofur and biology teacher of Public senior high school 1 Malang, Endah Sari Dewi, M. Pd (Table 1).

Table 1. Results of the expert review of the learning materials

| Learning Media                        | Average Score of Validation | Qualification |
|---------------------------------------|-----------------------------|---------------|
| Completeness of lesson plan components | 2.5                         | Good          |
| Indicator                             | 2.6                         | Good          |
| Learning objectives                   | 2.9                         | Good          |
| Learning materials                    | 2.8                         | Good          |
| Learning methods                      | 3                           | Good          |
| Learning Activities                   | 2.9                         | Good          |
| Assessment of learning results        | 3                           | Good          |
| Time Allocation                       | 3                           | Good          |
| Learning Resources                    | 3                           | Good          |
| Online Forum Design                   | 2.7                         | Good          |

Score: 1 = Bad; 2 = Enough; 3 = Good

The data collected in this research were metacognitive skills, learning results and students’ response toward the learning process. The data of metacognitive skills were collected using a pretest and posttest by using ten essay questions. The data of the learning results were obtained from pretest and the posttest in the cognitive domain. Metacognitive and Cognitive test items have met the content validity and have good reliability.

The data were then analysed by using Analysis of Covariance (ANCOVA) and Least Significance Difference (LSD) test, the which were previously performed the prerequisite tests namely, the normality test using one-sample Kolmogorov-Smirnov test and homogeneity test using Levene's Test of Equality of Error Variances.

3. RESEARCH RESULT

3.1. Metacognitive

Based on the results of the pretest and posttest, the data of metacognitive skills both in the experimental class and in the control class were obtained. The mean value of metacognitive skills in the experimental class in the pretest was 59.14, and the mean value of metacognitive skills in the posttest was 83.40. In the control group, the mean value of the metacognitive skills in the pretest was 63.97, and the mean value of the metacognitive skills in the posttest was 68.93 (Table 2).
Table 2. Summary of data description of metacognitive skills based on the results of the pretest and posttest

| Treatment | Mean Pretest | Std. deviation Pretest | N Pretest | Mean Posttest | Std. deviation Posttest | N Posttest |
|-----------|--------------|------------------------|----------|--------------|------------------------|----------|
| Control   | 63.97        | 8.9294                 | 35       | 68.93        | 8.9436                 | 35       |
| Experiment| 59.14        | 8.7897                 | 35       | 83.40        | 7.4338                 | 35       |

The results of the ANCOVA test show that the probability value was 0.00 less than 0.05 so that the null hypothesis was rejected and the research hypothesis was accepted. Thus it can be said that the learning using the module of blood circulation system with guided inquiry blended learning has an effect on metacognitive skills. The Summary of ANCOVA of the results of the data calculation of metacognitive skills both on the pretests and posttests are shown in Table 3.

Table 3. Summary of ANCOVA on the data calculation results of metacognitive skills on both pretest and posttest

| Source          | Type III sum of squares | df | Mean Square   | F     | Significance |
|-----------------|-------------------------|----|--------------|-------|--------------|
| Corrected Learning | 4834.088a              | 2  | 2417.044     | 47.223| .000         |
| Intercept       | 3096.477                | 1  | 3096.477     | 60.498| .000         |
| Treatment       | 4551.010                | 1  | 4551.010     | 88.916| .000*        |
| Pretest         | 1169.198                | 1  | 1169.198     | 22.843| .012         |
| Error           | 3429.273                | 67 | 51.183       |       |              |
| Total           | 414333.250              | 70 |              |       |              |
| Corrected Total | 8263.361                | 69 |              |       |              |

*) significance at p<0.05

The comparison of the corrected mean score of the experimental class and the control class shows that the experimental class with the learning using blood circulatory system with guided inquiry-based facilitated blended learning gives the corrected mean score of metacognitive skills bigger than that of the control class (Table 4).

Table 4. The corrected mean score of metacognitive skills

| Treatment | Pretest | Posttest | Difference | Corrected scores |
|-----------|---------|----------|------------|------------------|
| Control   | 63.97   | 68.93    | 4.96       | 67.80            |
| Experiment| 59.14   | 83.40    | 24.26      | 84.53            |

3.2. Learning Outcome: Cognitive

The mean scores the cognitive pretest and cognitive posttest of the experimental class were 63.17 and 85.63 respectively. The increase in the cognitive mean scores achieved by the experimental was 35.21%. In the control class, the mean scores of the pretest and posttest were 65.71 and 73.26. Thus, it can be seen that the increase of the mean score of the students’ learning outcome was 11.49% (Table 5).

Table 5. Summary of the Data Description of the pretest and posttest of cognitive learning outcome

| Treatment | Mean Pretest | Standard deviation Pretest | N Pretest | Mean Posttest | Standard deviation Posttest | N Posttest |
|-----------|--------------|---------------------------|----------|--------------|-----------------------------|----------|
| Control   | 65.71        | 6.479                     | 35       | 73.26        | 6.789                       | 35       |
| Experiment| 63.17        | 7.213                     | 35       | 85.63        | 6.890                       | 35       |
The results of ANCOVA showed that the probability value was 0.00 less than 0.05 so that the null hypothesis was rejected, and the research hypothesis was accepted. Thus, it can be concluded that the learning through guided inquiry blended learning improve the learning outcome. Summary of the results of ANCOVA on the cognitive learning outcome both in the pretest and posttest can be seen in Table 6.

**Table 6. Summary of ANCOVA on learning outcome**

| Source          | Type III sum of squares | df | mean Square | F     | Sig.  |
|-----------------|-------------------------|----|-------------|-------|-------|
| Corrected Learning | 4044.844a               | 2  | 2022.422    | 79.781| .000  |
| Intercept       | 1059.479                | 1  | 1059.479    | 41.795| .000  |
| Treatment       | 3328.868                | 1  | 3328.868    | 131.318| .000* |
| Pretests        | 1366.429                | 1  | 1366.429    | 53.903| .000  |
| Error           | 1698.428                | 67 | 25.350      |       |       |
| Total           | 447525.000              | 70 |             |       |       |
| Corrected Total | 5743.271                | 69 |             |       |       |

*) significance at p<0.05

The comparison of the mean corrected of the experimental class, and the control class shows that the experimental class with the learning using inquiry learning blended learning module gives bigger cognitive learning results than the control class (Table 7). In addition to quantitative data, the researcher also obtained qualitative data in the form of students’ feedback and suggestions on the blood circulatory system module with guided inquiry-based blended learning during the tryout. Feedback and suggestions can be seen in Table 8.

**Table 7. The corrected mean score of cognitive learning outcome**

| Treatment | Pretest | Posttest | Difference | Corrected scores |
|-----------|---------|----------|------------|------------------|
| Control   | 65.71   | 73.26    | 7.55       | 72.43            |
| Experiment| 63.17   | 85.63    | 22.46      | 86.46            |
Table 8. Students’ feedback and suggestions on module with guided inquiry-based blended learning

| Code number of students | Suggestions and feedback |
|-------------------------|--------------------------|
| 1                      | It is better to have an online discussion, but it would be best if the schedule is determined in advance Link to the video is interesting to learn |
| 2                      | Links to the videos are very helpful to my understanding during the lab practice It will be better if the text is colourful The language in the module is so simple that I can understand it more easily The module is difficult to be open via handphone; it was probably due to the Handphone Online discussion was fun, but it is with a friend, it takes a long time to answer |
| 3                      | The text will be better if colourful Do not use PDF format; it cannot be copied When accessed in Explorer, it is difficult to be opened Overall the module has been good The Lab activities were not in a good order The Module is difficult to be opened in HP I feel more comfortable to have an online discussion because I do not feel shy to ask |
| 4                      | Link to youtube is often difficult to access Difficult to access unless using Google Link to videos are lacking; it will be a lot better if there are more links to videos Online discussion is more fun Difficult to access using handphone |
| 5                      | The Online module helps me learn Chatting is good, but it depends on the internet connection at home |
| 6                      | The text is less artistic Modules are difficult to access in schools Link to youtube is difficult to access at school. Students should be told to download the video at home so that students can just open it at school I love Online discussions and class discussion |
| 7                      | The link is very good for learning, but unfortunately, it depends on the internet connection If it is possible, do not use PDF format Tasks are easier if the tasks are given in class The online class should be scheduled in advance |
| 8                      | The colour of the text and background is not contrasting The correcting of the learning task is better to be done during the classroom session The module is faster to be opened using a laptop than using an handphone The discussion with the teacher is better than that with friends because friends are slow response Learning using a module is simpler |

4. Discussion
The research results show that the guided inquiry facilitated blended learning improves metacognitive skills. The research results show that the students who were taught by using blended learning had better academic performance and learning outcomes than those taught by using traditional method [29]. The research [30] showed that the blended learning models contributed more to students’ attitudes toward geography course when compared to the traditional learning models; Blended
learning models contributed more to students’ critical dispositions and levels when compared to the traditional learning models. The research [31] indicates that blended learning has the potential to provide a better learning outcome. The research [32] showed that the blended learning support metacognitive processes, authentic learning activities, collaboration, motivation, individualised learning, and access to information on the Internet.

Students will get the best learning outcomes if they become reflective learners [33]. Metacognition refers to “thinking about thinking” [4]. Metacognition is an important objective of learning because students who do metacognition demonstrate the ability to reflect on what is known, what is not known, and how to manage and control the thinking processes, so that they can make a decision about what they want to learn more and evaluate whether they have been on the right process [34].

Currently, the students do not only compete with the students around them, but they compete with all the students from around the world [35]. Thus, today's technology needs to be utilised in learning activities. The technology utilised in education is to help the learning process and to improve the learning outcomes, not to learn the technology [36]. A similar opinion is also expressed by [34] that the application of technology in education improves learning opportunities for students, learning quality, the education quality of workers, and provides the opportunities to decline the injustice in education.

ICT (information and communication technology) creates motivation, has a positive effect on interaction and collaboration, and supports students’ ability to reflect on their learning [37]. Web-based inquiry learning helps students with cognitive tools and procedural guidance in the learning process [38]. Blended learning does not completely leave face to face session. The design is there is face to face activity and online activity. In general, the proposed proportion of face to face and online activities is half-and-half [29]. Through blended learning, the difficulties encountered in online learning activities can be solved by face to face discussion. Conversely, the difficulties encountered in face to face activity can be solved through online discussion.

Blended learning has the potential to improve learning, but there is also a challenge, especially in response to the complexity of the two environments, namely the online and face to face activities, as well as the acknowledgement of the online learning as a legitimate learning environment [39]. To date, the blended learning has been implemented in universities, but only a few high schools implement the blended learning. The next challenge is to strengthen the teacher as the blended learning teacher who should master the learning materials and the mastery of ICT as the medium of online learning [28]. Teachers need to gain access to information and technology [40]).

In the process of blended learning, teachers have to design the activities carried out at the online and face to face session, so that both media can make the students learning process effective [41]. Teachers who facilitate the blended learning effectively use information, communication, and modern learning materials; promote in-depth dialogue about the learning experience through online media; encourage participation and communication among students through online media; even help students who have difficulties in speaking with technology [40].

5. CONCLUSION

Biology learning with guided inquiry facilitated blended learning improves metacognitive skills and learning outcomes of high school students. In connection with the inquiry processes, metacognition is a reflective process to regulate and control the thinking processes to be in the right process of inquiry in solving problems. Inquiry through blended learning is made easier with the help of offline and online modules that have been developed by the teacher. Teacher-student communication barriers in the traditional inquiry process can be overcome with the online activity. The ease of the students to have a discussion with the teachers that is not bound to places and opportunities helps students solve the difficulties they have.

References

[1] Lai E R 2011 Metacognition: A Literature Review Pearson Research Report pp 40
http://images.pearsonassessments.com/images/tmrs/metacognition_literature_review_final.
pdf

[2] Ellis A K, Denton D W and Bond J B An 2014 Analysis of Research on Metacognitive Teaching Strategies Procedia - Soc. Behav. Sci. vol. 116 p. 4015–4024.

[3] Schwartz D L, Chase C, Chin D, Oppezzo M, Kwong H, Okita S, Roscoe R, Jeong H, Wagster J, and Biswas G 2009 To appear in D.J. Hacker, J. Dunlosky, & A.C. Graesser (Eds.), Handbook of Metacognition in Education pp. 340–358.

[4] Mahdavi M 2014 An Overview : Metacognition in Education Int. J. Multidiscip. Curr. Res. P. 529–535.

[5] Lin X 2001 Designing metacognitive activities Educ. Technol. Res. Dev. pp 23–40.

[6] Kuhn D 2000 Metacognitive Development Current Directions in Psychological Science, Vol. 9 no. 5. pp. 178-181

[7] Tanner K D 2011 Promoting Student Metacognition CBE-Life Sciences Education Vol.11 p. 113-120.

[8] Aleven V A W M M and Koedinger K R 2002 An effective metacognitive strategy: Learning by doing and explaining with a computer-based Cognitive Tutor Cogn. Sci. vol. 26 no. 2, pp 147–179.

[9] An Y J and Cao L 2014 Examining the Effects of Metacognitive Scaffolding on Students’ Design Problem Solving and Metacognitive Activities in an Online Environment Journal of Online Learning & Teaching vol. 10 no. 4 pp. 552–568

[10] Efklides A 2006 Metacognition and affect: What can metacognitive experiences tell us about the learning process Educ. Res. Rev. vol. 1 no. 1 p. 3–14

[11] Danoebroto S W 2008 Meningkatkan Kemampuan Pemecahan Masalah Melalui Pendekatan PMRI dan Pelatihan Metakognitif Jurnal Penelitian dan Evaluasi Pendidikan No.1 p. 73-87.

[12] Suratno 2011 Kemampuan Metakognisi dengan Metacognitive Awareness Inventory (MAI) pada Pembelajaran Biologi SMA dengan Strategi Jigsaw, Reciprocal Teaching (RT), dan Gabungan Jigsaw-RT Jurnal Pendidikan dan Pembelajaran, Vol 18 p. 11-18.

[13] Şahİn S M and Kendir F 2013 The Effect of Using Metacognitive Strategies for Solving Geometry Problems on Students’ Achievement and Attitude Educ. Res. Rev. vol. 8 no. 19 p. 1777–1792.

[14] Schraw G Crippen K J and Hartley K 2006 Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning Res. Sci. Educ. vol. 36 no. 1–2 p. 111–139.

[15] Eilam E 2015 Measuring the level of complexity of scientific inquiries: The LCSII index Int. J. Environ. Sci. Educ. vol. 10 no. 1 p. 1–20.

[16] Zimmerman C 2007 The development of scientific thinking skills in elementary and middle school Dev. Rev. vol. 27, no. 2 p. 172–223.

[17] Cavagnetto A R Hand B and Norton-Meier L 2010 Negotiating the Inquiry Question: A Comparison of Whole Class and Small Group Strategies in Grade Five Science Classrooms Res. Sci. Educ. vol. 41, no. 2 p. 193–209.

[18] Odegaard M Haug B Mork S and Sorvik G O 2015 Budding Science and Literacy. A Classroom Video Study of the Challenges and Support in an Integrated Inquiry and Literacy Teaching Model Procedia - Soc. Behav. Sci. vol. 167 no. 1877 p. 274–278.

[19] Hmelo-Silver C E Duncan R G and Chinn C A 2007 Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, and Clark (2006) Educ. Psychol. vol. 42 no. 2 p. 99–107.

[20] Zhang M 2013Supporting middle school students’ online reading of scientific resources: Moving beyond cursory, fragmented, and opportunistic reading J. Comput. Assist. Learn vol. 29 no. 2 p. 138–152.

[21] Choo S S Y Rotgans J I Yew E H J and Schmidt H G 2011 Effect of worksheet scaffolds on student learning in problem-based learning Adv. Heal. Sci. Educ. vol. 16 no. 4 p. 517–528.

[22] Ginns P and Ellis R 2007 Quality in blended learning: Exploring the relationships between online and face-to-face teaching and learning Internet High. Educ. vol. 10 no. 1 p. 53–64.

[23] Tsai A 2011 A Hybrid E-Learning Model Incorporating Some of the Principal Learning
Theories Soc. Behav. Personal. an Int. J. vol. 39 no. 2 p. 145–152.

[24] Watson J 2008 Blended Learning: The Convergence of Online and Face-to-Face Education North Am. Counc. Online Learn. vol. 572 p. 16.

[25] Cheung W S and Hew K F 2011 Design and evaluation of two blended learning approaches: Lessons learned Australasian Journal of Educational Technology vol. 27 no. 8 pp. 1319–1337.

[26] Thiagarajan S Semmel D S Semmel M I 1974 Instructional Development for Training Teachers of Exceptional Children (University of Minnesota: the Center for Innovation in Teaching the Handycapped)

[27] Creswell J W 2012 Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research (Boston: Pearson)

[28] Llewellyn D 2013 Teaching High School Science Through Inquiry and Argumentation (Thousand Oaks, California: Corwin)

[29] Greenberg B Medlock L and Stephens D 2011 Lessons Learned from a Blended Learning Pilot Blend My Learning,” p. 25.

[30] Ozgen K and Ufuk K 2009 The impact of blended learning model on student attitudes towards geography course and their critical thinking dispositions and levels Turkish Online J. Distance Educ. vol. 8 no. 4 p. 51–63.

[31] Means B Toyama Y Murphy R Baki M 2013 The effectiveness of online and blended learning: a meta-analysis of the empirical literature Teachers College Record vol. 115 p. 1-47

[32] Delialioglu O and Yildirim Z 2007 Students’ perception of effective dimensions of interactive learning in a blended learning environment Educational Technology & Society vol. 10 no. 2 p. 133-146

[33] Bryce J, Frigo T, McKenzie P, and G. Withers 2001 The Era of Lifelong Learning: Implications for Secondary Schools http://research.acer.edu.au/lifelong_learning/

[34] Sternberg R J 2009 Foreword to Handbook of Metacognition in Education Handbook of Metacognition in Education eds D J Hacker, J D Dunlosky, A C Graesser (Abingdon, Oxon: Roudlege) pp viii-ix

[35] Wang Y Han X and Yang J 2015 Revisiting the Blended Learning Literature: Using a Complex Adaptive Systems Framework Educational Technology & Society vol. 18 no. 2 pp 380–393

[36] Bach S Haynes P and Smith J L 2006 Online learning and teaching in higher education (Buckingham, UK: Open University Press).

[37] Svendsen L P and Mondahl M S 2013 How social-media enhanced learning platforms support students in taking responsibility for their own learning J. Appl. Res. High. Educ. vol. 5 no. 2 pp 261–272.

[38] Lim B R 2004 Challenges and issues in designing inquiry on the Web Br. J. Educ. Technol. vol. 35, no. 5 pp 627–643.

[39] Jeffrey L M Milne J Saddaby G and Higgins A 2014 Blended learning: How teachers balance the blend of online and classroom components Journal of Information Technology Education: Research vol. 13 p. 121-140. Retrieved from http://www.jite.org/documents/ Vol13/JITEv13ResearchP121-140Jeffrey0460.pdf

[40] National Research Council 2007 Enhancing professional development for teachers: Potential uses of information technology (Washington, DC: The National Academies Press)

[41] Marsh D 2012 Blended Learning Creating Learning Opportunities for Language Learners (Cambridge: University Press)