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Research Artikel

THE EFFECTIVENESS OF INQUIRY LESSON-BASED IMMUNITY SYSTEM MODULE TO EMPOWER THE STUDENTS' CRITICAL THINKING SKILL

EFEKTIFITAS MODUL SISTEM IMUNITAS BERBASIS PEMBELAJARAN INQUIRY DALAM MEMEBERDAYAKAN KETRAMPILAN PEMIKIRAN KRITIS SISWA

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Abstract

This research aimed to find out the effectiveness of inquiry lesson (IL)-based immunity system module product to empower the students' critical thinking skill. This study was quasi-experimental research with pretest-posttest control group design nonequivalent. The participant or subject of research consisted of 67 Senior High School students in Kediri in Academic Year of 2016/2017 distributed in two classes: 33 students in the 11th Natural Science 2 Grade as experiment class and 34 students in the 11th Natural Science 3 Grade as existing class. The instrument used to collect data on critical thinking skill was essay test. Experiment class was treated using inquiry lesson-based module, and existing class using module commonly used at school. Data analysis employed t-test at significance level with p-value = 0.000 ($p<0.05$). The gap between pre- and posttest scores was 20.99% for experiment class and 10.76% for existing class. From the result of research, it could be concluded that learning using inquiry lesson (IL)-based immunity system in learning process is very significant to empower the students' critical thinking skill.

Keywords: module; immunity system; inquiry lesson; critical thinking skill

Abstrak

Penelitian ini bertujuan untuk mengetahui keefektifan produk modul sistem imunitas berbasis inquiry lesson (IL) untuk memberdayakan keterampilan berpikir kritis siswa. Penelitian ini merupakan penelitian kuasi-eksperimental dengan pretest-posttest control group design nonequivalent. Partisipan subjek penelitian dilakukan di salah satu Sekolah Menengah Atas di Kediri tahun Akademik 2016/2017 berjumlah 67 siswa didistribusikan di dua kelas yaitu 33 siswa kelas XI IPA 2 sebagai kelas eksperimen dan 34 siswa kelas XI IPA 3 sebagai kelas eksiting. Instrumen test keterampilan berpikir kritis menggunakan test essay. Perlakuan penelitian pada kelas eksperimen menggunakan modul berbasis inquiry lesson dan kelas eksiting menggunakan modul umum yang digunakan di sekolah. Analisis data menggunakan uji-t pada taraf signifiansi nilai p = 0,000 (p<0,05). Gap skor pra dan pasca tes adalah 20,99% kelas eksperimen sedangkan kelas eksiting 10,76%. Hasil penelitian disimpulkan bahwa pembelajaran menggunakan modul sistem imunitas berbasis inquiry lesson (IL) dalam proses pembelajaran sangat signifikan untuk memberdayakan keterampilan berpikir kritis siswa.

***Kata Kunci**: modul, sistem imunitas, inquiry lesson, keterampilan berpikir kritis*

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INTRODUCTION

Twenty-first-century witnesses significantly rapid development in science and technology sectors. The 21st-century skill is required to master critical thinking skill very desirable in labor force in the education sector. Education will enable the students to acquire competency in skill considered as an important part of the curriculum (Kalelioğlu & Gülbahar, 2014; Taghva et.al, 2014). High-quality education is student-centered and enables the students to achieve the level higher than the one expected to make them thinking critically, doing critical thinking, improving imagination, being

creative, solving the problem, and making positive critique () . The teacher should teach and practice the students' explicit critical thinking to empower the critical thinking skill as the important focus of successful education (Dawit T Tiruneh et.al, 2014; Carmichael & Farrell, 2012).

Critical thinking skill is to think logically, rationally and reflectively, and a mental process of analyzing or evaluating information systematically to decide appropriately what action to do and is credible in the process of approaching and solving problem based on persuasive, logical, and rational argument, involving verification, evaluating, and choosing an appropriate answer is given and reasoning declination as another alternative solution (Hasslöf et.al, 2016; Ennis, 2011; Facione, 2011). Critical thinking skill enables the students to have precision, perception, and the concept of various ways of dealing with and solving the existing problem (Larsson, 2017; Thompson, 2011). Critical thinking skill equips the students to deal with the future challenge in making decision, reasoning, constructing opinion, analyzing, evaluating, assessing information, maintaining conclusion, explaining reason, dealing with and solving many problems in daily life in globalization era (Huang et.al, 2017; Thomas, 2017; Kuldas et.al, 2013).

The development of critical thinking skill is very important to do to explore an individual's self-potency (Aun & Kaewurai, 2017; Ahrari et.al, 2016). Critical thinking skill makes an individual having habits of mind, so he/she develops into a tough one as problem solver with argumentative conception and high complexity with good evaluation and analytical precision, identified and then objective in the problem existing, and having elaboration and metacognitive abilities (*Dwyer et.al, 2015; ; Chukwuyenum, 2013)*. Critical thinking skill can be practiced in formal schools through interaction between teachers and students visualized in learning process activity (Haseli, 2013; Thompson, 2011). Students are expected to find their ideas and to bring out new transformation (Kang & Keinonen, 2017; ; Lunenburg, 2011). Considering the result of field observation, it can be seen that the learning process activity is teacher-centered and has not involved activity participation yet, thereby less experience and understanding in constructing their knowledge and practicing and developing critical thinking skill inadequately.

The result of observation on Senior High Schools in Kediri shows that the poor mastery of science is closely related to learning quality. The analysis on 8 National Education Standard (*Standard Nasional Pendidikan*, thereafter called SNP) shows that the GAP is 1.42% in content standard, 2.38% in process standard, 0.00% in graduation standard, 0.48% in educator and education staff standard, 1.43% in infrastructure standard, 0.00% in management standard, 0.00% in funding standard, and 1.43% in assessment standard. The data shows that process standard has a high gap. In reality, the highest gap indicates the less maximum implementation of learning process activity.

The result of analysis on National Exam shows that percentage mastery of Biology material in one of the Senior High Schools in Kediri has low absorbability in three successive years in immunity system material, with the mean score obtained of 79.81%, 25.35%, and 55.14% in 2012/2013 (BSNP, 2013), 2013/201`4 (BSNP, 2014) and 2014/2015 (BSNP, 2015), respectively. This percentage belongs to a low category.

Viewed from percentage analysis on teaching material in practicing critical thinking skill, the aspects of assessment in text 2 of Biology book (Book I), text 2 of Biology Book (Book II), and text 2 of Biology Book (Book III) obtained the following percentage: 1) 52.08%, 45.83%, 45.83% in interpretation 2) 46.87%, 40.62%, 37.56% in analysis, 3) 40.62%, 50.00%, 46.87%, in evaluation, 4) 44.44%, 44.44%, 36.10% in conclusion, 5) 40.00%, 46.25%, 41.25% in explanation, and 6) 9.37%, 12.25%, 15.62% in self-regulation aspects. Considering the percentage obtained in teaching material analysis, it can be concluded that the six indicators of critical thinking skill have not been met optimally, thereby leading to the inadequate activity of exploring the students' potential critical thinking skill. Therefore, the gap between the real condition and the fact, based on the elaboration above, needs more reform and development. Solution to this problem is to develop module corresponding to the learning model using

the scientific approach of 2013 curriculum to empower the students' critical thinking skill.

The attempt of improving learning outcome can be taken by applying learning model appropriate to the 2013 curriculum using such innovative learning models as inquiry learning model. Inquiry level includes Discovery learning, Interactive demonstration, Inquiry lesson, inquiry laboratory (Guided inquiry laboratory, Bounded Inquiry Laboratory, Free Inquiry Laboratory), Real world application; Hypothetical inquiry (Wenning, 2011). Inquiry learning model has some advantages encouraging the improvement of students' KPS (Nline et.al, 2010). The result of the test on inquiry-level skill shows that the percentage achievement is shown at every level as follows: 79.26% in Discovery Learning, 2) 74.13% in Interactive Demonstration, 3) 52.42% in Inquiry Lesson, 4) 44.36% in Guided Inquiry Laboratory, 5) 36.47% in Bounded Inquiry Laboratory. Considering the result of the test on students' inquiring skill, it can be found that the results at level 1 and level 2 belong to good criterion, while those at levels 3-5 to the poor criterion. The data obtained in inquiry lesson level becomes an appropriate learning model used in the class, as the students have been ready to use the level, in which the inquiry lesson-level skill of 52.42% still belongs to poor category, so that the students are ready to use inquiry lesson as the learning model applied in the class. Inquiry lesson model as learning application is expected to be the teachers' method of empowering the students' critical thinking skill. In addition to learning model and teaching material in the form of module, the important supporting component also supports the learning process so that learning activity can run optimally.

The module is a series of planned learning activity that is independent as a flexible learning system strategy, interactive implementation, and can potentially empower the critical thinking skill equipped with activities, and training integrating learning activity into the module. The module developed by the author in immunity system is designed to be oriented to inquiry lesson learning model integrated into critical thinking skill aspect (Soulios & Psillos, 2016; Jocz et.al, 2014; Howell & Saye, 2017; Nline et.al, 2010).

Inquiry lesson-based module developed by author in immunity system material is expected to create a space for the students to think critically and to find solution actively, to help the students learning meaningfully as the content of material developed becomes the training of critical thinking skill, so that the students' perspective on immunity system material changes from recitation to conception (understanding), can find concept and construct their own knowledge in solving problem and explore the students' learning mastery level so that the module can be a potential means of empowering the critical thinking skill maximally (S. C. Fang & Hsu, 2017; Strippel & Sommer, 2015; Lederman et.al, 2013;Wenning et.al, 2011).

METHOD

This research was conducted using the descriptive quantitative method. The sampling technique used in this research was purposive random sampling one. The sample participants of research were the 11^{th} graders in one of the Senior High Schools in Kediri in Academic year of 2016/2017, consisting of 67 students, distributed in two classes: 33 students in the 11^{th} Natural Science 2 grade in experiment class and 34 students in the 11^{th} Natural Science 3 grade as existing class. The students were 16-18 years old. This research employed quasi-experimental method with *pretest-posttest nonequivalent control Group Design.* Experiment class employed inquiry lesson-based module and existing class employed the module existing in the class. Both classes took pretest first before received treatment and then took posttest. The module was developed using Research and Development method referring to Borg and Gall's (1993) model, adapted into nine stages.

Procedure

The development of early draft inquiry lesson (IL)-based module in immunity system material is assessed by expert validator stating validity based on module material and development and learning set corresponding to the targeted qualification. It is indicated by the result of validation by material expert obtaining a mean score of 91.44% belonging

to very good category, by module developing expert obtaining a score of 93.42% belonging to very good category, and by learning set expert from beginning to end stages obtaining a score of 100% belonging to very good category. Limited trial on the first revision of the product, as validated by education practitioners, obtained mean scores of 93.75%, 94.79% and 91.66 %, belonging to very good category. The assessment on small group users, consisting of 15 students, obtained score of 88.82% belonging to very good category. The next revision was validated by experts. Overall, the module has very good qualification so that it is feasible to be used, applied, and tried out in experiment class to find out the effectiveness of module. The characteristic of *inquiry lesson* (IL)-based module develops learning syntax of inquiry lesson including observation, manipulation, generalization, verification, and application integrated into Facione's six aspects of critical thinking including interpretation, analysis, evaluation, inference, explanation, and self-regulation aspect developed and designed, thereby practicing, exploring thinking skill and encouraging the students to find learning concept actively and independently.

The instrument of collecting data used to measure critical thinking skill is critical thinking item of essay test developed by the author based on Facione's (2011) six aspects: interpretation, analysis, evaluation, conclusion, explanation, and self-regulation. Such the type of test item is intended to obtain data of students' critical thinking skill in both experiment and existing classes. The essay test item instrument has a scoring interval of 1-4 corresponding to respective criteria. Instrument validity test was conducted using Pearson's Product Moment correlational test with the following terms: if r statistic > r table, the item is considered as valid, and if r statistic < r table, the item is considered as invalid and is removed. The instrument of validity test obtained the lowest score of 0.345 and highest one of 0.674 > f table, with 33 students as respondents with r value = 0.344 (r product moment value), meaning that the instrument of critical thinking skill item was valid. Meanwhile, the reliability test obtained Cronbach Alpha 0.913 > 0.344, meaning that each of items is reliable, implemented in the experiment and existing classes.

Technique of Analyzing Data

To find out the effectiveness of module after the learning process activity, normalized gain score (<g>) was used in pretest and posttest in both experiment and existing classes. The calculation of normalized gain score was interpreted using gain level criteria between pretest and posttest scores in both experiment and existing classes, as presented in Figure 1 and Table 1.

Table 1. Interpretation of N-Gain score Index Criteria

N-Gain	Interpretation
$0.7 < g < 1$	High
$0.3 \leq g \leq 0.7$	Moderate
$0 < g < 0.3$	Low

Source: (Hake, 1999)

Notes for Figure 1
<g> = gain factor
S pre = mean score of pretest (%)
S post = mean score of posttest (%)

Hypothesis testing was conducted using t-test at a significance level < 0.05. A t-test was conducted, and normality and homogeneity tests should be conducted. In this case, normality test is intended to reveal the distribution of critical thinking skill data scores in both classes. In this research, normalization test was conducted using Kolmogorov-Smirnov test. Homogeneity test was conducted to see whether or not the variance of critical thinking skill data in both experiment and existing classes is as same as that using Levene test. Homogeneity test was intended to reveal whether or not there is a similarity of variance between two classes. The analysis was conducted using SPSS program.

RESULT AND DISCUSSION

The result of research shows the data of test on critical thinking skill aspects, according to Facione (2011), including six indicators: interpretation, analysis, evaluation, inference, explanation and self-regulation aspects; gain score of pretest and posttest for the 11^{th} Natural Science 2 grade as experiment and the 11^{th} Natural Science 3 grade as

existing classes. The result of comparative data analysis shows gain score of critical thinking skill per aspect between experiment and existing classes in pretest and posttest, as presented in Table 2.

Table 2. Result of Comparative Data of critical thinking skill aspect scores between students in experiment and existing classes

No	Aspect of Critical Thinking Skill	Experiment Class		Existing Class	
		Pre test	Pos ttest	Pre test	Post test
1	Interpretation	61.62	80.18	58.58	69.36
2	Analysis	57.32	79.97	55.88	65.77
3	Evaluation	58.33	79.92	54.90	63.48
4	Inference	57.20	78.41	55.27	66.05
5	Explanation	58.84	79.29	56.05	67.40
6	Self-regulation	63.89	85.35	60.54	73.77
	Average	59.53	80.52	56.87	67.63

Table 2 shows that overall there is an increase in gain score of pretest and posttest between experiment and existing classes. The implementation of inquiry lesson-based module in immunity system material contributes positively to the potential of empowering the students' critical thinking skill, measuring six basic aspects including interpretation, analysis, evaluation, conclusion, explanation, and self-regulation. Considering the result, it can be concluded that experiment class using module obtain higher mean score in the six aspects of critical thinking skill with the highest percentage gap increase of 16.44% occurring in evaluation aspect, followed with analysis aspect (14.20%), inference (12.36%), self-regulation (11.58%), and interpretation (10.08%). The experiment class obtains mean score of 59.53% in the pretest, and 80.52% in the posttest. Based on the result of pretest and posttest, it can be seen that there is a gap of 20.99% in experiment class.

The gain score of pretest and posttest is calculated to find out the effectiveness of critical thinking skill improvement, using normalized gain score formula interpreted using gain level criteria (Hake, 1999). The result of the N-gain score for experiment and existing classes is shown in Table 3.

Table 3. Result of Mean N-gain score of critical thinking skill for experiment and existing classes

Category	Experiment Class		Existing class	
	Pre test	Post test	Pre test	Post test
Mean	57.83	80.13	56.76	67.28
Highest Score	72.50	87.50	65.83	74.17
Lowest Score	37.67	70.00	45.83	61.67
Standard Deviation	7.60	4.71	4.80	2.58
Average Gain	0.52		0.24	

Table 3 shows that the highest mean gain score of critical thinking skill is 0.52 found in experiment class and the lowest one is 0.24 found in existing class. The implementation of inquiry lesson-based module in immunity system material contributes effectively to empowering the critical thinking skill in experiment class.

Data of students' critical thinking N-gain value are analyzed using prerequisite test (normality and homogeneity) to conduct an advanced test to examine the effectiveness of IL-based module in empowering the critical thinking skill. Summary of Result of N-gain score analysis on students' critical thinking skill is presented in Table 4.

Table 4 shows that the data of gain score for experiment and existing classes are normally distributed but not homogenous, so that parametric test is then conducted using t-test. Considering the result of the t-test, it can be found significance level of 0.000 ($p < 0.05$), meaning that there is a significant difference of critical thinking skill scores between students in experiment class and those in existing class. N-gain of experiment class is higher than that of existing class. Thus, it can be concluded that the application of learning using inquiry lesson-based module in immunity system material more effectively empowers the students' critical thinking skill.

Table 4. Summary of N-gain score test result of Critical Thinking Skill

Data of score	Normality Test Sig. (α=0.05)		Homogeneity Test Sig. (α=0.05)	T-test	
	Experiment class	Existing Class		Sig. (α=0.05)	Meaning
N-gain	0.200 (normal)	0.200 (normal)	0.007 (not homogeneous)	0.000	There is a significant difference

Table 5. The result of n-gain analysis on each aspect of critical thinking skill for the students in experiment class

Indicator	N-Gain	Criteria
Interpretation	0.4667	Moderate
Analysis	0.5239	Moderate
Evaluation	0.4806	Moderate
Inference	0.4578	Moderate
Explanation	0.5236	Moderate
Self-regulation	0.6061	Moderate

The analysis on N-gain score for the improvement of critical thinking skill per aspect to find out the effectiveness of IL model-based module in improving every aspect is summarized in Table 5.

Table 5. The result of n-gain analysis per an aspect of students' critical thinking skill in experiment class.

From table 5, it can be found the effectiveness of IL model-based module in empowering the critical thinking skill. The improvement occurs in every aspect with averagely moderate improvement occurring in each of interpretation, analysis, evaluation, inference, explanation and self-regulation indicators.

The effectiveness of IL-based module in immunity system material potentially empowers the students' critical thinking skill in aspects of interpretation, analysis, evaluation, inference, explanation, and self-regulation. Critical thinking skill is also a part of higher-order thinking skill (King et.al, 2013; Facione, 2011) . The effectiveness of module can be seen from the improvement of students' critical thinking skill, with an n-gain score of 0.52 (moderate category) for experiment class and 0.24 (low category) for existing class. From the result of the t-test, it can be found that probability (p) value is 0.000 ($p < 0.05$), so that Ho is not supported meaning that there is a significant difference of critical thinking skill score between students in experiment class and those in existing class. It indicates that the application of inquiry lesson-based module learning in immunity system material effectively empowers the students' critical thinking skill. This finding is inline with previous studies stating that inquiry activity contributes significantly and effectively to empowering the students' critical thinking skill (Hairida, 2016; Wardani et.al, 2016). Discovery or investigation learning activity process can be conducted using Inquiry Lesson-based syntax model (Wenning et.al, 2011).

The learning using inquiry lesson (IL) module affects positively the improvement of students' critical thinking skill (Dawit Tibebu Tiruneh et.al, 2017; Alnofaie, 2013). The module is very effective and reliable in giving positive feedback to the teaching. Therefore, using the module as teaching and learning strategy in technical education can be an alternative approach and give significant contribution (*Smallhorn et.al, 2015;)*. The use of module with inquiry lesson teaching model in experiment group is significant and effective, as indicated with the significant difference of achievement between empowered the students' potential critical thinking skill more experiment and existing classes. It means that inquiry teaching model has effectively in the experiment than in existing class (Selvi & Martin-Beltrán, 2016). *Critical thinking skill can contribute significantly to education development and other developments related to all students' achievement* ; Dil et.al, 2015). A comprehensive, transformative learning process requires the students to have a broad perspective based on experience through the critical reflecting process (Carter et.al, 2016; Forawi, 2016).

Inquiry learning is designed to be integrated into science in the class, so that the students develop and understand the real world through questioning, looking for answer to a question duly by means of prediction, exploration, communication through experience and scientific knowledge, evidence, and empirical study to empower the students' potential critical thinking skill (Nuangchalerm, 2017; ; Wenning et. al, 2011). Inquiry learning is very effective and plays central role, motivates science learning to achieve the good learning effect, directs and expands learning

thereby allowing for the explicit teaching, develops students' investigation ability, and improving students' skill comprehensively (Preston et.al, 2015; Škoda et.al, 2015). Inquiry Lesson (IL) module helps students to achieve self-development, encourage the students to explore potential intellectual critical thinking skill maximally. The students can learn at their own pace using the instructional module and interest in improving their self-confidence in their learning (Rasmawan, 2017; Padmapriya, 2015; Kluge, 2014; Marin & Halpern, 2011).

The result of operational field trial shows data of pretest and posttest for critical thinking skill that is then analyzed to find out the effectiveness of its improvement (Mundilarto & Helmiyanto Ismoyo, 2017). The improvement of students' critical thinking skill during the learning process indicates the effectiveness of inquiry lesson (IL)-based module. The first IL syntax includes observing and identifying the problems leading to a response from surrounding phenomena (Kukkonen et.al, 2014). This syntax can practice critical thinking skill in interpretation aspect (Aloqaili, 2012). The second IL syntax is manipulation, debating anything possible to investigate and develop an approach that can be used to learn the phenomena by making a plan to collect data and then implementing the plan (Nline et.al, 2010). This syntax can practice critical thinking skill in analysis and evaluation aspects (Qamar, 2016; Hyytinen et.al, 2015). The third IL-syntax is a generalization, making generalization or drawing conclusion based on the finding and giving reasonable explanation about the phenomena. This syntax can practice critical thinking skill in inference aspect (Aun & Kaewurai, 2017; Ricketts & Rudd, 2004). The fourth IL syntax is verification, including predicting, testing, and using concept coming from the previous stage through other problems concerning the similar thing to discuss it again. This syntax can practice critical thinking skill in explanation aspect (Ricketts & Rudd, 2004). The fifth IL syntax is application, giving varying approach to do and to be applied to other media. This syntax can practice critical thinking skill in self-regulation aspect (Gelerstein et.al, 2016).

Critical thinking also is also a part of high-order thinking skill (González-González & Jiménez-Zarco, 2015; Saadé et.al, 2012). The development of students' critical thinking skill can use article and case study in finding and solving problem in the learning. Both article and case study can be another alternative for the teachers, so that they will not apply conventional teaching-learning process (*Chen et.al, 2014Balgopal et.al, 2017; ;)*. It is intended to give the students a means and an opportunity of exploring thinking skill not only scientifically but also conceptually (S. C. Fang & Hsu, 2017;). The nurturant effect of case study and the appeal of this article are that the students' curiosity is revived and stimulated, and it develops knowledge, conception and reasoning on students' scientific ideas and communication (Fang et.al, 2016; Peeters et..al, 2016). This finding confirms another relevant study stating that practicing critical thinking can be done through solving a problem (Haseli, 2013). Teacher is required to be capable of managing the class well and more wisely, facilitating more efficiently and giving the students more space and time to participate actively in the learning, practicing them to construct conception on new information in organized and systematic manner, so that they can be information users rather than information receiver (Stender et.al, 2017; Kapanadze et.al, 2015; Bunterm et.al, 2014), and develop logical thinking skill more creatively, integrate and construct new meaningful knowledge to produce individuals with logical, rational and more independent thinking skill (Marzuki & Basariah, 2017;). Inquiry Lesson (IL) learning module gives the students an opportunity of achieving self-development in learning activity, encourages them to explore their intellectual potency, their critical thinking skill maximally and structured thinking process in inquiry lesson-based module (*Dobber et.al, 2017;)*. Inquiry learning enables the students to describe an object, to pose question, to acquire knowledge, to construct an explanation of phenomena, to test and to explain the phenomena in varying ways and to communicate ideas with clarity and reliability, to improve students' character and conception concept effectively, thereby making them science-literate comprehensively and improving their learning quality *(Akilli & Genç, 2017; Cruz-Guzmán et.al, 2017; ; Wenning, 2012). Inquiry learning facilitates the students to learn authentic content, ensure that*

the students develop critical thinking skill, encourage independent learning, and solve the problems through collaborative learning, communicative, knowledge construction and expand learning experience and is important to professional successfulness. Teaching and learning with inquiry lesson (IL)-based module learning activity can improve the exploration and the empowerment of students' critical thinking skill. This approach is considered as an effective way potential facilitating the learning in the 21st-century learning *(Nuangchalerm, 2017; ; Waters, 2012).*

CONCLUSION

Considering the result of the analysis, it can be concluded that the application of learning with inquiry lesson (IL)-based module in immunity system effectively empowers the students' critical thinking skill. The effectiveness of module product can be seen from the significance of critical thinking skill in the learning application using the module, as the result of statistic analysis test shows that the t-test obtains significance level of 0.000 ($p < 0.05$), meaning that there is a significant difference between experiment and existing classes. The result of N-gain score calculation shows that the students' critical thinking skill is 0.52 in experiment class (moderate category) and 0.24 in existing class (low category). The increase in N-gain score occurs in each of indicators with the moderate category. Therefore, inquiry lesson-based module for immunity system material effectively empowers the students' critical thinking skill in interpretation, analysis, evaluation, inference, explanation, and self-regulation aspects.

REFERENCES

Ahrari, S., Samah, B. A., Hassan, M. S. H. Bin, Wahat, N. W. A., & Zaremohzzabieh, Z. (2016). Deepening critical thinking skills through civic engagement in Malaysian higher education. Thinking Skills and Creativity, 22. http://doi.org/10.1016/j.tsc.2016.09.009

Ahuna, K. H., College, M., Tinnesz, C. G., Ahuna, K. H., & Tinnesz, C. G. (2014). A New Era of Critical Thinking in Professional Programs Key Words :, 7(3), 1–9.

Akilli, M., & Genç, M. (2017). Modelling the Effects of Selected Affective Factors on Learning Strategies and Classroom Activities in Science Education. Journal of Baltic Science Education, 16(4), 599–611. Retrieved from https://wgu.idm.oclc.org/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=124837210&site=eds-live&scope=site

Alnofaie, H. (2013). A framework for implementing critical thinking as a language pedagogy in EFL preparatory programmes. Thinking Skills and Creativity, 10, 154–158. http://doi.org/10.1016/j.tsc.2013.09.002

Aloqaili, A. S. (2012). The relationship between reading comprehension and critical thinking: A theoretical study. Journal of King Saud University - Languages and Translation, 24(1), 35–41. http://doi.org/10.1016/j.jksult.2011.01.001

Aun, S., & Kaewurai, W. (2017). Kasetsart Journal of Social Sciences Instructional model development to enhance critical thinking and critical thinking teaching ability of trainee students at regional teaching training center in Takeo province , Cambodia. Kasetsart Journal of Social Sciences, 38(1), 88–95. http://doi.org/10.1016/j.kjss.2016.05.002

Balgopal, M. M., Casper, A. M. A., Atadero, R. A., & Rambo-Hernandez, K. E. (2017). Responses to different types of inquiry prompts: college students' discourse, performance, and perceptions of group work in an engineering class. International Journal of Science Education, 39(12), 1625–1647. http://doi.org/10.1080/09500693.2017.1346847

Bunterm, T., Lee, K., Ng Lan Kong, J., Srikoon, S., Vangpoomyai, P., Rattanavongsa, J., & Rachahoon, G. (2014). Do Different Levels of Inquiry Lead to Different Learning Outcomes? A comparison between guided and structured inquiry. International Journal of Science Education, 36(12), 1937–1959. http://doi.org/10.1080/09500693.2014.886347

Carmichael, E., & Farrell, H. (2012). Evaluation of the Effectiveness of Online Resources in Developing Student Critical Thinking : Review of Literature and Case Study of a Critical Thinking Online Site, 9(1).

Carter, A. G., Creedy, D. K., & Sidebotham, M. (2016). Development and psychometric testing of the Carter Assessment of Critical Thinking in Midwifery (Preceptor/Mentor version). Midwifery,

34, 141–149. http://doi.org/10.1016/j.midw.2015.12.002

Chen, H. T., Wang, H. H., Lin, H. S., Lawrenz, F. P., & Hong, Z. R. (2014). Longitudinal Study of an After-school, Inquiry-based Science Intervention on Low-achieving Children's Affective Perceptions of Learning Science. International Journal of Science Education, 36(13), 2133–2156. http://doi.org/10.1080/09500693.2014.910630

Cruz-Guzmán, M., García-Carmona, A., & Criado, A. M. (2017). An analysis of the questions proposed by elementary pre-service teachers when designing experimental activities as inquiry. International Journal of Science Education, 39(13), 1755–1774. http://doi.org/10.1080/09500693.2017.1351649

DeWitt, D., Siraj, S., & Alias, N. (2013). [JOURNAL BI] Collaborative mlearning: A module for learning secondary school science. Educational Technology and Society, 17(1), 89–101.

Dil, Y., Öğretildiği, O., & Sınıflarında, D. (2015). International Journal of Language Academy DEVELOPING CRITICAL THINKING SKILLS IN ENGLISH LANGUAGE TEACHING CLASSES, 3, 76–90.

Dobber, M., Zwart, R., Tanis, M., & van Oers, B. (2017). Literature review: The role of the teacher in inquiry-based education. Educational Research Review, 22, 194–214. http://doi.org/10.1016/j.edurev.2017.09.002

Dolphin, G., & Benoit, W. (2016). Students' mental model development during historically contextualized inquiry: how the "Tectonic Plate" metaphor impeded the process. International Journal of Science Education, 38(2), 276–297. http://doi.org/10.1080/09500693.2016.1140247

Dunne, G. (2015). Beyond critical thinking to critical being: Criticality in higher education and life. International Journal of Educational Research, 71, 86–99. http://doi.org/10.1016/j.ijer.2015.03.003

Dwyer, C. P., Hogan, M. J., & Stewart, I. (2015). The effects of argument mapping-infused critical thinking instruction on reflective judgement performance. Thinking Skills and Creativity, 16, 11–26. http://doi.org/10.1016/j.tsc.2014.12.002

Emir, S. (2009). Education faculty students' critical thinking disposition according to achedemic achievement. Procedia - Social and Behavioral Sciences, 1(1), 2466–2469. http://doi.org/10.1016/j.sbspro.2009.01.433

Facione, P. A. (2011). Critical Thinking : What It Is and Why It Counts. Journal Measured Reasons and The California Academic Press, 27(1), 1-26

Fang, S.-C., Hsu, Y.-S., Chang, H.-Y., Chang, W.-H., Wu, H.-K., & Chen, C.-M. (2016). Investigating the effects of structured and guided inquiry on students' development of conceptual knowledge and inquiry abilities: a case study in Taiwan. International Journal of Science Education, 38(12), 1945–1971. http://doi.org/10.1080/09500693.2016.1220688

Fang, S. C., & Hsu, Y. S. (2017). Understanding science teachers' enactments of a computer-based inquiry curriculum. Computers and Education, 112, 69–82. http://doi.org/10.1016/j.compedu.2017.05.004

Forawi, S. A. (2016). Standard-based science education and critical thinking. Thinking Skills and Creativity, 20. http://doi.org/10.1016/j.tsc.2016.02.005

Gelerstein, D., Río, R. del, Nussbaum, M., Chiuminatto, P., & López, X. (2016). Designing and implementing a test for measuring critical thinking in primary school. Thinking Skills and Creativity, 20, 40–49. http://doi.org/10.1016/j.tsc.2016.02.002

González-González, I., & Jiménez-Zarco, A. I. (2015). Using learning methodologies and resources in the development of critical thinking competency: An exploratory study in a virtual learning environment. Computers in Human Behavior, 51, 1359–1366. http://doi.org/10.1016/j.chb.2014.11.002

Hairida. (2016). the Effectiveness Using Inquiry Based Natural Science Module With Authentic Assessment To Improve the Critical Thinking and Inquiry Skills of Junior High. Jurnal Pendidikan IPA Indonesia, 5(2), 209–215. http://doi.org/10.15294/jpii.v5i2.7681

Hake, R. (1999). Analiyzing Change/Gain Score. Dept. of Physics, Indiana University, 1–4.

Haseli, Z. (2013). The Effect of Teaching Critical thinking on Educational Achievement and Test Anxiety among Junior High School Students in Saveh, 2(2), 168–175.

Hasslöf, H., Lundegård, I., & Malmberg, C. (2016). Students' qualification in environmental and sustainability education—epistemic gaps or composites of critical thinking? International Journal of Science Education, 38(2), 259–275. http://doi.org/10.1080/09500693.2016.1139756

Howell, J. B., & Saye, J. W. (2017). Integrating theory and practice: Factors shaping elementary teachers′ interpretation of an inquiry model for teaching social studies. The Journal of Social Studies Research. http://doi.org/10.1016/j.jssr.2017.04.003

Hyytinen, H., Nissinen, K., Ursin, J., Toom, A., & Lindblom-Ylänne, S. (2015). Problematising the equivalence of the test results of performance-based critical thinking tests for undergraduate students. Studies in Educational Evaluation, 44, 1–8. http://doi.org/10.1016/j.stueduc.2014.11.001

Ješková, Z., Lukáč, S., Hančová, M., Šnajder, Ľ., Guniš, J., Balogová, B., & Kireš, M. (2016). Efficacy of inquiry-based learning in mathematics, physics and informatics in relation to the development of students' inquiry skills. Journal of Baltic Science Education, 15(5), 559–574.

Jocz, J. A., Zhai, J., & Tan, A. L. (2014). Inquiry Learning in the Singaporean Context: Factors affecting student interest in school science. International Journal of Science Education, 36(15), 2596–2618. http://doi.org/10.1080/09500693.2014.908327

Kalelioğlu, F., & Gülbahar, Y. (2014). The Effect of Instructional Techniques on Critical Thinking and Critical Thinking Dispositions in Online Discussion, 17, 248–258.

Kang, J., & Keinonen, T. (2017). The effect of inquiry-based learning experiences on adolescents' science-related career aspiration in the Finnish context. International Journal of Science Education, 39(12), 1669–1689. http://doi.org/10.1080/09500693.2017.1350790

Kapanadze, M., Bolte, C., Schneider, V., & Slovinsky, E. (2015). Enhancing science teachers' continuous professional development in the field of inquiry based science education. Journal of Baltic Science Education, 14(2), 254–266.

King, F., Goodson, L., & Rohani, F. (2013). Higher Order Thinking Skills • Definition • Teaching Strategies • Assessment. Higher Order Thinking Skills • Definition • Teaching Strategies • Assessment, (Higher Order Thinking Skills), 1–177.

Kluge, A. (2014). Combining Laboratory Experiments with Digital Tools to Do Scientific Inquiry. International Journal of Science Education, 36(13), 2157–2179. http://doi.org/10.1080/09500693.2014.916456

Kukkonen, J. E., Kärkkäinen, S., Dillon, P., & Keinonen, T. (2014). The Effects of Scaffolded Simulation-Based Inquiry Learning on Fifth-Graders' Representations of the Greenhouse Effect. International Journal of Science Education, 36(3), 406–424. http://doi.org/10.1080/09500693.2013.782452

Larsson, K. (2017). Understanding and teaching critical thinking—A new approach. International Journal of Educational Research, 84(December 2016), 32–42. http://doi.org/10.1016/j.ijer.2017.05.004

Lederman, N. G., Lederman, J. S., Nature, A., Lederman, N. G., Lederman, J. S., & Antink, A. (2013). International Journal of Education in Mathematics , Science and Technology (IJEMST) Nature of Science and Scientific Inquiry as Contexts for the Learning of Science and Achievement of Scientific Literacy Nature of Science and Scientific Inquiry as Conte.

Lunenburg, F. C. (2011). Critical Thinking and Constructivism Techniques for Improving Student Achievement, 21(3), 1–9.

Marin, L. M., & Halpern, D. F. (2011). Pedagogy for developing critical thinking in adolescents : Explicit instruction produces greatest gains. Thinking Skills and Creativity, 6(1), 1–13. http://doi.org/10.1016/j.tsc.2010.08.002

Meltzer, D. E. (2002). The relationship between mathematics preparation and conceptual learning gains in physics: A possible "hidden variable" in diagnostic pretest scores. American Journal of Physics, 70(12), 1259–1268. http://doi.org/10.1119/1.1514215

Mundilarto, & Helmiyanto Ismoyo. (2017). Effect of Problem-Based Learning on Improvement Physics Achievement and Critical Thinking of Senior High School Student. Journal of Baltic Sience Education, 16(5), 761–780.

Nline, O., Jackson, J., & Wenning, C. J. (2010). sequences to teach science, Journal of Physics Teacher Education , 5(4).

Noprianda, M., Noor, M. F., & Zulfiana. (2016). KETERAMPILAN BERPIKIR KRITIS SISWA MODEL PEMBELAJARAN PROBLEM BASED LEARNING DAN SAINS TEKNOLOGI MASYARAKAT PADA KONSEP VIRUS., Journal EDUSAINS, 8(2), 182–191. http://journal.uinjkt.ac.id/index.php/edusains

Nuangchalerm, P. (2017). Inquiry-based Learning in China : Lesson learned for School Science

Practices, 10(13), 64–71. http://doi.org/10.5539/ass.v10n13p64

Padmapriya, P. V. (2015). Effectiveness of Self Learning Modules on Achievement in Biology Among Secondary School Students. International Journal Of Education and Psychological Research (IJEPR), 4(2), 44–46.

Peeters, M. J., Zitko, K. L., & Schmude, K. A. (2016). Development of Critical Thinking in Pharmacy Education, 7(1).

Preston, L., Harvie, K., Wallace, H., & Harvie, K. (2015). Inquiry-based Learning in Teacher Education : A Primary Humanities Example, 40(12).

Qamar, F. (2016). Effectiveness of Critical Thinking Skills for English Literature Study with Reader Response Theory : A Review of Literature, 37–50.

Ricketts, J. C., & Rudd, R. (2004.). Critical Thinking Skills of FFA Leaders John C. Ricketts, University of Georgia Rick Rudd, University of Florida. Agricultural Education, 54(1), 7–20.

Sa'adah, S., Sudargo, F., & Hidayat, T. (2017). PENGUASAAN KONSEP MAHASISWA PADA MATA KULIAH ZOOLOGI VERTEBRATA MELALUI TEAM-BASED LEARNING DAN HUBUNGANNYA DENGAN KETERAMPILAN BERPIKIR KRITIS, Journal EDUSAINS, 9(1), 89–99. Retrieved from http://journal.uinjkt.ac.id/index.php/edusains

Saadé, R. G., Morin, D., & Thomas, J. D. E. (2012). Critical thinking in E-learning environments. Computers in Human Behavior, 28(5), 1608–1617. http://doi.org/10.1016/j.chb.2012.03.025

Selvi, A. F., & Martin-Beltrán, M. (2016). Teacher-learners' engagement in the reconceptualization of second language acquisition knowledge through inquiry. System, 63, 28–39. http://doi.org/10.1016/j.system.2016.08.006

Shin, H., Park, C. G., & Kim, H. (2015). Validation of Yoon â€TM s Critical Thinking Disposition Instrument. Asian Nursing Research, 9(4), 342–348. http://doi.org/10.1016/j.anr.2015.10.004

Škoda, J., Doulík, P., Bílek, M., & Šimonová, I. (2015). The effectiveness of inquiry based science education in relation to the learners´ motivation types. Journal of Baltic Science Education, 14(6), 791–803.

Smallhorn, M., Young, J., Hunter, N., & Burke da Silva, K. (2015). Inquiry-based learning to improve student engagement in a large first year topic. Student Success, 6(2), 65–71. http://doi.org/10.5204/ssj.v6i2.292

Soulios, I., & Psillos, D. (2016). Enhancing student teachers' epistemological beliefs about models and conceptual understanding through a model-based inquiry process. International Journal of Science Education, 38(7), 1212–1233. http://doi.org/10.1080/09500693.2016.1186304

Stender, A., Brückmann, M., & Neumann, K. (2017). Transformation of topic-specific professional knowledge into personal pedagogical content knowledge through lesson planning. International Journal of Science Education, 39(12), 1690–1714. http://doi.org/10.1080/09500693.2017.1351645

Strippel, C. G., & Sommer, K. (2015). Teaching Nature of Scientific Inquiry in Chemistry: How do German chemistry teachers use labwork to teach NOSI? International Journal of Science Education, 37(18), 2965–2986. http://doi.org/10.1080/09500693.2015.1119330

Taghva, F., Rezaei, N., Ghaderi, J., & Taghva, R. (2014). Studying the Relationship between Critical Thinking Skills and Students ' Educational Achievement (Eghlid Universities as Case Study), 25, 18–25. http://doi.org/10.18052/www.scipress.com/ILSHS.25.18

Tajvidi, M., Ghiyasvandian, S., & Salsali, M. (2014). Probing Concept of Critical Thinking in Nursing Education in Iran : A Concept Analysis. Asian Nursing Research, 8(2), 158–164. http://doi.org/10.1016/j.anr.2014.02.005

Thomas, T. (2017). Developing First Year Students ' Critical Thinking Skills, Asian Social Science. 7(4), 26–35. http://doi.org/10.5539/ass.v7n4p26

Thompson, C. (2011). Critical Thinking across the Curriculum : Process over Output, International Journal of Humanities and Social Science ,1(9), 1–7.

Tiruneh, D. T., De Cock, M., Weldeslassie, A. G., Elen, J., & Janssen, R. (2017). Measuring Critical Thinking in Physics: Development and Validation of a Critical Thinking Test in Electricity and Magnetism. International Journal of Science and Mathematics Education, 15(4). http://doi.org/10.1007/s10763-016-9723-0

Tiruneh, D. T., Verburgh, A., & Elen, J. (2014). Effectiveness of Critical Thinking Instruction in Higher Education : A Systematic Review of

Intervention Studies, 4(1). http://doi.org/10.5539/hes.v4n1p1

Turiman, P., Omar, J., Daud, A. M., & Osman, K. (2012). Fostering the 21 st Century Skills through Scientific Literacy and Science Process Skills, 59, 110–116. http://doi.org/10.1016/j.sbspro.2012.09.253

Wardani, S., Nurhayati, S., & Safitri, A. (2016). The Effectiveness of the Guided Inquiry Learning Module towards Students' Character and Concept Understanding. International Journal of Science and Research, 5(6), 1589–1594.

Wenning, C. J. (2012). The Levels of Inquiry Model of Science Teaching, 6(January). Journal of Physics Teacher Education, 1-16

Wenning, C. J., Ed, D., Khan, M. A., Lecturer, S., Khan, A., & Secondary, H. (2011). Levels of Inquiry Model of Science Teaching : Learning sequences to lesson plans, Journal of Physics Teacher Education, 6(2), 17–20.

Zuiker, S., & Whitaker, J. R. (2014). Refining Inquiry with Multi-Form Assessment: Formative and summative assessment functions for flexible inquiry. International Journal of Science Education, 36(6), 1037–1059. http://doi.org/10.1080/09500693.2013.834489

Ahrari, S., Samah, B. A., Hassan, M. S. H. Bin, Wahat, N. W. A., & Zaremohzzabieh, Z. (2016). Deepening critical thinking skills through civic engagement in Malaysian higher education. Thinking Skills and Creativity, 22. http://doi.org/10.1016/j.tsc.2016.09.009

Ahuna, K. H., College, M., Tinnesz, C. G., Ahuna, K. H., & Tinnesz, C. G. (2014). A New Era of Critical Thinking in Professional Programs Key Words :, 7(3), 1–9.

Akilli, M., & Genç, M. (2017). Modelling the Effects of Selected Affective Factors on Learning Strategies and Classroom Activities in Science Education. Journal of Baltic Science Education, 16(4), 599–611. Retrieved from https://wgu.idm.oclc.org/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=124837210&site=eds-live&scope=site

Alnofaie, H. (2013). A framework for implementing critical thinking as a language pedagogy in EFL preparatory programmes. Thinking Skills and Creativity, 10, 154–158. http://doi.org/10.1016/j.tsc.2013.09.002

Aloqaili, A. S. (2012). The relationship between reading comprehension and critical thinking: A theoretical study. Journal of King Saud University - Languages and Translation, 24(1), 35–41. http://doi.org/10.1016/j.jksult.2011.01.001

Aun, S., & Kaewurai, W. (2017). Kasetsart Journal of Social Sciences Instructional model development to enhance critical thinking and critical thinking teaching ability of trainee students at regional teaching training center in Takeo province , Cambodia. Kasetsart Journal of Social Sciences, 38(1), 88–95. http://doi.org/10.1016/j.kjss.2016.05.002

Balgopal, M. M., Casper, A. M. A., Atadero, R. A., & Rambo-Hernandez, K. E. (2017). Responses to different types of inquiry prompts: college students' discourse, performance, and perceptions of group work in an engineering class. International Journal of Science Education, 39(12), 1625–1647. http://doi.org/10.1080/09500693.2017.1346847

Bunterm, T., Lee, K., Ng Lan Kong, J., Srikoon, S., Vangpoomyai, P., Rattanavongsa, J., & Rachahoon, G. (2014). Do Different Levels of Inquiry Lead to Different Learning Outcomes? A comparison between guided and structured inquiry. International Journal of Science Education, 36(12), 1937–1959. http://doi.org/10.1080/09500693.2014.886347

Carmichael, E., & Farrell, H. (2012). Evaluation of the Effectiveness of Online Resources in Developing Student Critical Thinking : Review of Literature and Case Study of a Critical Thinking Online Site, 9(1).

Carter, A. G., Creedy, D. K., & Sidebotham, M. (2016). Development and psychometric testing of the Carter Assessment of Critical Thinking in Midwifery (Preceptor/Mentor version). Midwifery, 34, 141–149. http://doi.org/10.1016/j.midw.2015.12.002

Chen, H. T., Wang, H. H., Lin, H. S., Lawrenz, F. P., & Hong, Z. R. (2014). Longitudinal Study of an After-school, Inquiry-based Science Intervention on Low-achieving Children's Affective Perceptions of Learning Science. International Journal of Science Education, 36(13), 2133–2156. http://doi.org/10.1080/09500693.2014.910630

Cruz-Guzmán, M., García-Carmona, A., & Criado, A. M. (2017). An analysis of the questions proposed by elementary pre-service teachers when designing experimental activities as inquiry. International

Journal of Science Education, 39(13), 1755–1774. http://doi.org/10.1080/09500693.2017.1351649

DeWitt, D., Siraj, S., & Alias, N. (2013). [JOURNAL BI] Collaborative mlearning: A module for learning secondary school science. Educational Technology and Society, 17(1), 89–101.

Dil, Y., Öğretildiği, O., & Sınıflarında, D. (2015). International Journal of Language Academy DEVELOPING CRITICAL THINKING SKILLS IN ENGLISH LANGUAGE TEACHING CLASSES, 3, 76–90.

Dobber, M., Zwart, R., Tanis, M., & van Oers, B. (2017). Literature review: The role of the teacher in inquiry-based education. Educational Research Review, 22, 194–214. http://doi.org/10.1016/j.edurev.2017.09.002

Dolphin, G., & Benoit, W. (2016). Students' mental model development during historically contextualized inquiry: how the "Tectonic Plate" metaphor impeded the process. International Journal of Science Education, 38(2), 276–297. http://doi.org/10.1080/09500693.2016.1140247

Dunne, G. (2015). Beyond critical thinking to critical being: Criticality in higher education and life. International Journal of Educational Research, 71, 86–99. http://doi.org/10.1016/j.ijer.2015.03.003

Dwyer, C. P., Hogan, M. J., & Stewart, I. (2015). The effects of argument mapping-infused critical thinking instruction on reflective judgement performance. Thinking Skills and Creativity, 16, 11–26. http://doi.org/10.1016/j.tsc.2014.12.002

Emir, S. (2009). Education faculty students' critical thinking disposition according to achedemic achievement. Procedia - Social and Behavioral Sciences, 1(1), 2466–2469. http://doi.org/10.1016/j.sbspro.2009.01.433

Facione, P. A. (2011). Critical Thinking : What It Is and Why It Counts. Journal Measured Reasons and The California Academic Press, 27(1), 1-26

Fang, S.-C., Hsu, Y.-S., Chang, H.-Y., Chang, W.-H., Wu, H.-K., & Chen, C.-M. (2016). Investigating the effects of structured and guided inquiry on students' development of conceptual knowledge and inquiry abilities: a case study in Taiwan. International Journal of Science Education, 38(12), 1945–1971. http://doi.org/10.1080/09500693.2016.1220688

Fang, S. C., & Hsu, Y. S. (2017). Understanding science teachers' enactments of a computer-based inquiry curriculum. Computers and Education, 112, 69–82. http://doi.org/10.1016/j.compedu.2017.05.004

Forawi, S. A. (2016). Standard-based science education and critical thinking. Thinking Skills and Creativity, 20. http://doi.org/10.1016/j.tsc.2016.02.005

Gelerstein, D., Río, R. del, Nussbaum, M., Chiuminatto, P., & López, X. (2016). Designing and implementing a test for measuring critical thinking in primary school. Thinking Skills and Creativity, 20, 40–49. http://doi.org/10.1016/j.tsc.2016.02.002

González-González, I., & Jiménez-Zarco, A. I. (2015). Using learning methodologies and resources in the development of critical thinking competency: An exploratory study in a virtual learning environment. Computers in Human Behavior, 51, 1359–1366. http://doi.org/10.1016/j.chb.2014.11.002

Hairida. (2016). the Effectiveness Using Inquiry Based Natural Science Module With Authentic Assessment To Improve the Critical Thinking and Inquiry Skills of Junior High. Jurnal Pendidikan IPA Indonesia, 5(2), 209–215. http://doi.org/10.15294/jpii.v5i2.7681

Hake, R. (1999). Analiyzing Change/Gain Score. Dept. of Physics, Indiana University, 1–4.

Haseli, Z. (2013). The Effect of Teaching Critical thinking on Educational Achievement and Test Anxiety among Junior High School Students in Saveh, 2(2), 168–175.

Hasslöf, H., Lundegård, I., & Malmberg, C. (2016). Students' qualification in environmental and sustainability education—epistemic gaps or composites of critical thinking? International Journal of Science Education, 38(2), 259–275. http://doi.org/10.1080/09500693.2016.1139756

Howell, J. B., & Saye, J. W. (2017). Integrating theory and practice: Factors shaping elementary teachers' interpretation of an inquiry model for teaching social studies. The Journal of Social Studies Research. http://doi.org/10.1016/j.jssr.2017.04.003

Hyytinen, H., Nissinen, K., Ursin, J., Toom, A., & Lindblom-Ylänne, S. (2015). Problematising the equivalence of the test results of performance-based critical thinking tests for undergraduate students. Studies in Educational Evaluation, 44, 1–8. http://doi.org/10.1016/j.stueduc.2014.11.001

Ješková, Z., Lukáč, S., Hančová, M., Šnajder, Ľ., Guniš, J., Balogová, B., & Kireš, M. (2016). Efficacy of inquiry-based learning in mathematics, physics and informatics in relation to the development of students' inquiry skills. Journal of Baltic Science Education, 15(5), 559–574.

Jocz, J. A., Zhai, J., & Tan, A. L. (2014). Inquiry Learning in the Singaporean Context: Factors affecting student interest in school science. International Journal of Science Education, 36(15), 2596–2618. http://doi.org/10.1080/09500693.2014.908327

Kalelioğlu, F., & Gülbahar, Y. (2014). The Effect of Instructional Techniques on Critical Thinking and Critical Thinking Dispositions in Online Discussion, 17, 248–258.

Kang, J., & Keinonen, T. (2017). The effect of inquiry-based learning experiences on adolescents' science-related career aspiration in the Finnish context. International Journal of Science Education, 39(12), 1669–1689. http://doi.org/10.1080/09500693.2017.1350790

Kapanadze, M., Bolte, C., Schneider, V., & Slovinsky, E. (2015). Enhancing science teachers' continuous professional development in the field of inquiry based science education. Journal of Baltic Science Education, 14(2), 254–266.

King, F., Goodson, L., & Rohani, F. (2013). Higher Order Thinking Skills • Definition • Teaching Strategies • Assessment. Higher Order Thinking Skills • Definition • Teaching Strategies • Assessment, (Higher Order Thinking Skills), 1–177.

Kluge, A. (2014). Combining Laboratory Experiments with Digital Tools to Do Scientific Inquiry. International Journal of Science Education, 36(13), 2157–2179. http://doi.org/10.1080/09500693.2014.916456

Kukkonen, J. E., Kärkkäinen, S., Dillon, P., & Keinonen, T. (2014). The Effects of Scaffolded Simulation-Based Inquiry Learning on Fifth-Graders' Representations of the Greenhouse Effect. International Journal of Science Education, 36(3), 406–424. http://doi.org/10.1080/09500693.2013.782452

Larsson, K. (2017). Understanding and teaching critical thinking—A new approach. International Journal of Educational Research, 84(December 2016), 32–42. http://doi.org/10.1016/j.ijer.2017.05.004

Lederman, N. G., Lederman, J. S., Nature, A., Lederman, N. G., Lederman, J. S., & Antink, A. (2013). International Journal of Education in Mathematics , Science and Technology (IJEMST) Nature of Science and Scientific Inquiry as Contexts for the Learning of Science and Achievement of Scientific Literacy Nature of Science and Scientific Inquiry as Conte.

Lunenburg, F. C. (2011). Critical Thinking and Constructivism Techniques for Improving Student Achievement, 21(3), 1–9.

Marin, L. M., & Halpern, D. F. (2011). Pedagogy for developing critical thinking in adolescents : Explicit instruction produces greatest gains. Thinking Skills and Creativity, 6(1), 1–13. http://doi.org/10.1016/j.tsc.2010.08.002

Meltzer, D. E. (2002). The relationship between mathematics preparation and conceptual learning gains in physics: A possible "hidden variable" in diagnostic pretest scores. American Journal of Physics, 70(12), 1259–1268. http://doi.org/10.1119/1.1514215

Mundilarto, & Helmiyanto Ismoyo. (2017). Effect of Problem-Based Learning on Improvement Physics Achievement and Critical Thinking of Senior High School Student. Journal of Baltic Sience Education, 16(5), 761–780.

Nline, O., Jackson, J., & Wenning, C. J. (2010). sequences to teach science, Journal of Physics Teacher Education , 5(4).

Noprianda, M., Noor, M. F., & Zulfiana. (2016). KETERAMPILAN BERPIKIR KRITIS SISWA MODEL PEMBELAJARAN PROBLEM BASED LEARNING DAN SAINS TEKNOLOGI MASYARAKAT PADA KONSEP VIRUS., Journal EDUSAINS, 8(2), 182–191. http://journal.uinjkt.ac.id/index.php/edusains

Nuangchalerm, P. (2017). Inquiry-based Learning in China : Lesson learned for School Science Practices, 10(13), 64–71. http://doi.org/10.5539/ass.v10n13p64

Padmapriya, P. V. (2015). Effectiveness of Self Learning Modules on Achievement in Biology Among Secondary School Students. International Journal Of Education and Psychological Research (IJEPR), 4(2), 44–46.

Peeters, M. J., Zitko, K. L., & Schmude, K. A. (2016). Development of Critical Thinking in Pharmacy Education, 7(1).

Preston, L., Harvie, K., Wallace, H., & Harvie, K. (2015). Inquiry-based Learning in Teacher Education : A Primary Humanities Example, 40(12).

Qamar, F. (2016). Effectiveness of Critical Thinking Skills for English Literature Study with Reader Response Theory : A Review of Literature, 37–50.

Ricketts, J. C., & Rudd, R. (2004.). Critical Thinking Skills of FFA Leaders John C. Ricketts, University of Georgia Rick Rudd, University of Florida. Agricultural Education, 54(1), 7–20.

Sa'adah, S., Sudargo, F., & Hidayat, T. (2017). PENGUASAAN KONSEP MAHASISWA PADA MATA KULIAH ZOOLOGI VERTEBRATA MELALUI TEAM-BASED LEARNING DAN HUBUNGANNYA DENGAN KETERAMPILAN BERPIKIR KRITIS, Journal EDUSAINS, 9(1), 89–99. Retrieved from http://journal.uinjkt.ac.id/index.php/edusains

Saadé, R. G., Morin, D., & Thomas, J. D. E. (2012). Critical thinking in E-learning environments. Computers in Human Behavior, 28(5), 1608–1617. http://doi.org/10.1016/j.chb.2012.03.025

Selvi, A. F., & Martin-Beltrán, M. (2016). Teacher-learners' engagement in the reconceptualization of second language acquisition knowledge through inquiry. System, 63, 28–39. http://doi.org/10.1016/j.system.2016.08.006

Shin, H., Park, C. G., & Kim, H. (2015). Validation of Yoon â€TM s Critical Thinking Disposition Instrument. Asian Nursing Research, 9(4), 342–348. http://doi.org/10.1016/j.anr.2015.10.004

Škoda, J., Doulík, P., Bílek, M., & Šimonová, I. (2015). The effectiveness of inquiry based science education in relation to the learners´ motivation types. Journal of Baltic Science Education, 14(6), 791–803.

Smallhorn, M., Young, J., Hunter, N., & Burke da Silva, K. (2015). Inquiry-based learning to improve student engagement in a large first year topic. Student Success, 6(2), 65–71. http://doi.org/10.5204/ssj.v6i2.292

Soulios, I., & Psillos, D. (2016). Enhancing student teachers' epistemological beliefs about models and conceptual understanding through a model-based inquiry process. International Journal of Science Education, 38(7), 1212–1233. http://doi.org/10.1080/09500693.2016.1186304

Stender, A., Brückmann, M., & Neumann, K. (2017). Transformation of topic-specific professional knowledge into personal pedagogical content knowledge through lesson planning. International Journal of Science Education, 39(12), 1690–1714. http://doi.org/10.1080/09500693.2017.1351645

Strippel, C. G., & Sommer, K. (2015). Teaching Nature of Scientific Inquiry in Chemistry: How do German chemistry teachers use labwork to teach NOSI? International Journal of Science Education, 37(18), 2965–2986. http://doi.org/10.1080/09500693.2015.1119330

Taghva, F., Rezaei, N., Ghaderi, J., & Taghva, R. (2014). Studying the Relationship between Critical Thinking Skills and Students ' Educational Achievement (Eghlid Universities as Case Study), 25, 18–25. http://doi.org/10.18052/www.scipress.com/ILSHS.25.18

Tajvidi, M., Ghiyasvandian, S., & Salsali, M. (2014). Probing Concept of Critical Thinking in Nursing Education in Iran : A Concept Analysis. Asian Nursing Research, 8(2), 158–164. http://doi.org/10.1016/j.anr.2014.02.005

Thomas, T. (2017). Developing First Year Students ' Critical Thinking Skills, Asian Social Science. 7(4), 26–35. http://doi.org/10.5539/ass.v7n4p26

Thompson, C. (2011). Critical Thinking across the Curriculum : Process over Output, International Journal of Humanities and Social Science ,1(9), 1–7.

Tiruneh, D. T., De Cock, M., Weldeslassie, A. G., Elen, J., & Janssen, R. (2017). Measuring Critical Thinking in Physics: Development and Validation of a Critical Thinking Test in Electricity and Magnetism. International Journal of Science and Mathematics Education, 15(4). http://doi.org/10.1007/s10763-016-9723-0

Tiruneh, D. T., Verburgh, A., & Elen, J. (2014). Effectiveness of Critical Thinking Instruction in Higher Education : A Systematic Review of Intervention Studies, 4(1). http://doi.org/10.5539/hes.v4n1p1

Turiman, P., Omar, J., Daud, A. M., & Osman, K. (2012). Fostering the 21 st Century Skills through Scientific Literacy and Science Process Skills, 59, 110–116. http://doi.org/10.1016/j.sbspro.2012.09.253

Wardani, S., Nurhayati, S., & Safitri, A. (2016). The Effectiveness of the Guided Inquiry Learning

Module towards Students' Character and Concept Understanding. International Journal of Science and Research, 5(6), 1589–1594.

Wenning, C. J. (2012). The Levels of Inquiry Model of Science Teaching, 6(January). Journal of Physics Teacher Education, 1-16

Wenning, C. J., Ed, D., Khan, M. A., Lecturer, S., Khan, A., & Secondary, H. (2011). Levels of Inquiry Model of Science Teaching : Learning sequences to lesson plans, Journal of Physics Teacher Education, 6(2), 17–20.

Zuiker, S., & Whitaker, J. R. (2014). Refining Inquiry with Multi-Form Assessment: Formative and summative assessment functions for flexible inquiry. International Journal of Science Education, 36(6), 1037–1059. http://doi.org/10.1080/09500693.2013.834489