THE EVALUATION OF SCIENCE LEARNING PROGRAM, TECHNOLOGY AND SOCIETY APPLICATION OF AUDIO BIO HARMONIC SYSTEM WITH SOLAR ENERGY TO IMPROVE CROP PRODUCTIVITY

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ABSTRACT

One of the greatest challenges in science learning is how to integrate a wide range of basic scientific concepts of physics, chemistry, and biology into an integrated learning material. Research-based teaching material in this area is still very poor and does not much involve students of science education in its implementation as part of the learning program science technology and society (STS). The purpose of this study is to get the result of evaluation of the teaching and learning of STS in the form of public service in Kulon Progo, Yogyakarta. The program to improve crop productivity through the application of Audio Bio Harmonic System (ABHS) with solar energy have been selected for utilizing the natural animal sounds to open stomata of the leaves conducted during foliar fertilization, making it suitable for integrated science lessons. Component of evaluation model used is Stufflebeam model evaluation (CIPP). CIPP evaluation in these activities resulted in two aspects: The first aspect was improving the skills of students and farmers in using ABHS, and these two aspects, namely food crop productivity; (1) cayenne increased 76.4%, (2) increased red onions (56.3%) and (3) of maize increased by 67.8%. Besides, it was also the effect of the application of ABHS on the rate of plant growth. The outcome of this study is the STS teaching materials and appropriate technology of ABHS with solar energy.

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Keywords: evaluation; science technology and society; audio bioharmonic; crop productivity

INTRODUCTION

Science learning in curriculm 2013 is done integratedly to give a chance to studnets to develop their thinking ability, process skill, and scientific attitude. The meaning of integration in science learning is the existence of a relation between some aspects and material presented on the basic competence of science, so it creates one or some themes based context in learning. Context based learning could improve soft skill and give a positive influence towards student's value which includes in valuing affective (Rosana, et al., 2014).

The development of integrated learning could take one topic of certain fields; then it is completed, discussed, expanded and deeply explained wioth other fields. The theme could be developed from the issue, happening, and problem. What is developed in this study is the application of Audio Bio Harmonic System (ABHS) with solar energy to improve crop productivity. Giving sound wave with frequency 3000 – 6000 hertz to some plants could stimulate stomata to open (Yulianto, 2008).

The integration in science learning is supposed to make the learning process more meaningful, effective, and effecient. Students could take advantages by knowing concepts and show their ability to connect those concepts to daily life (Wijayanti & Basyar, 2016). The integrati-

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on could also improve scientific literacy so students could know and realize social needs so that they could participate in the economy-oriented economy (Sofowora & Adekomi, 2012). Science, technology, and society are learning reformation to provide social needs related to technology.

The condition of technology applied in STS leanring process could be seen in the figure below:
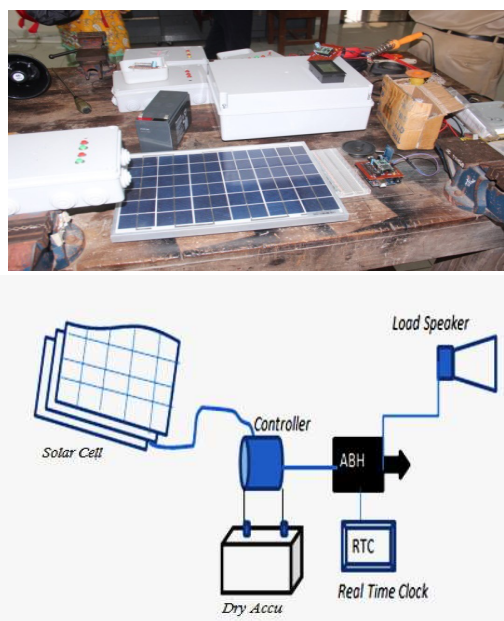

Figure 1. The use of solar energy to apply ABHS by using natural animal sounds.

This study more pointed to the program evaluation of STM which was done at Science education program, Yogyakarta State University through the application of evaluation model CIPP (context, input, process, and product). The basis for choosing this model saw learning concept where the quality of learning process in STS (Sains Technology and Society) was at least influenced by input, process, and product (Issac & William., 1981). The evaluation of this Stufflebeam model is suggested to be systematical framework as the reference of conception, design, implementation, and assessment of community service program, and give feedback and the assessment of project effectivity to continous improvement (Zhang et al., 2011).

Implementing research and applying ABHS to improve crop productivity are in the concept of CIPP combined with Provus, so it becomes modification. Many types of research evaluating learning process at STM has not been conducted variously and implemented in the community service program directly through field activity by involving students of science education program. This CIPP model uses some methods, which have been tested in many contexts, developed and strengthened from time to time, and supported by theoritical nad phragmatic literature (Stufflebeam, 1971).

STS learning process has a better influence towards students of SHS in understanding nature of science and their attitude towards science than students taught by the same teacher using a traditionally oriented textbook (Akcay & Akcay, 2015). Students using STS approach performed better in understanding the scientific process, their ability to apply scientific concepts related to science and technology, more possitive attitude, and their creativity (bakar et al., 2016). Science learning should always refer to nature of science taught through three aspects; product process, and attitude (Prabowo, 2015).

Evaluation problem towards STS program which is integrated with community service program in improving crop productivity is quite complex because it affects directly to farmers empowerment. Rasionally, Stufflebeam & Shinkfield referred to Tyler opinion who said that: "evaluation should determine the congruence between performance and objectives" (Stufflebeam & Shinkfield, 1985). The evaluation has to result in the same opinion between work and real condition, it could not be manipulated, and it should avoid subjectivity. Learning program should be evaluated to know the weaknesess and deficiency in the process of STS learning espcesially what is related directly to farmer' need. Reviewed from the perpective of STS program continousity, relevant knowledge that could be inserted in the program should be guided by social opinion and responsibility. This case, in its turn, needs new type which is appropriate to STS education targetted and done on purpose so that it is oriented to literacy (Zoller, 2012).

This research has benefit to building a new instrument model to evaluate STS learning program in improving crop productivity through applying Audio Bio Harmonic System (ABHS) with solar energy through the program of modificated evaluation model between CIPP model and Provus which is called evaluation model "Coni P2". This research is also used to evaluate a program designed in the form of community service program to give help to STS staffs in science education program Faculty of Science and Mathematics in determining whether this program should be stopped, continued, or repaired. Worthen & Sanders explained that: "evaluation is the process of delineating, obtaining, and providing

useful information for judging decision alternatives" (Worthen & Sanders, 1981).

METHODS

This research is an evaluative research (Suharsimi & Jabar, 2010) because it was oriented to the analysis based on program evaluation approach focusing on organizing the program, it was a view showing procedure and process of the program . the component of evaluation model used was Stufflebeam evaluation model (CIPP). The steps used were Malcolm Povus'. The techniques of colecting data were Delphi, FGD, questionnaire, observation, interview and documentation study. Besides, the writer also analyzed program preparation by analyzing variables in CIPP model that was confirmed with a target which was the measurement of program readiness. This research involved four variables; they were context, input, process, and product (Daryanto, 2008).

The population in this research was 37 students taking biophysics class and 25 farmers incorporating with two groups in Pengasih subdistrict, Kulon Progo regency, Yogyakarta; they were Tani Ngudi Makmur group and Tani Ngudi Luhur group in Kedungsari village. Taking sample was done by using non-probability sampling in the forms of purposive sampling and quota sampling. The amount of sample was 3 farmers (chili farmer, onion farmer, and long bean farmer). The data were gathered by using a questionnaire to know students' and farmers' opinion extensively. The instrument in this research consisted of four components; they were ontext variable, input, process, and product, which consisted of some questions related to STS program in applying ABHS to improve crop productivity.

The data taken from observation and interview towards farmers and students were then analyzed by organizing them into categories, explaining into some units, done syntetically, and arranged in patterns to ease the interpretation. The data were divided into two, qualitative and quantitative. Quantitative data were analyzed by Explora-tory Factor Analysis (EFA) with the help of SPSS 20.0 application. The laten variable was formed based on theoritical concept with some indicators/manifests (Gozhali, 2008). The purpose of using EFA was to test whether the formed construct could be explained its indicators or not. If the indicators could explain the available construct or variable, the validity would be showed in high loading factor value. Each item in the content whould be higher than 0,3 (>0,3), as the oppsotie, if the item was lower than 0,3 (<0,3), it was considered as not valid, it shoudl be thrown or deleted, Nurosis (1086). The construct was tested by seeing the value of Kaiser Mayer Olkin (KMO) which was expected to be higher than 0,5 (>0,5). The analysis with EFA to test the validity was done in the second test and construct normality test before being analyzed with CFA in the third test. The reliablity of data measurement was seen from its alpha value. If the alpha value was >0,7, the instrument was reliable, and if it was <0,7, it was not reliable.

Test by using Cronbach Alpha was used to know instrument reliablity in the trial test. The result was the analyzed by using CFA model to know the validity of each instrument; they were context, input, prcess, and product. Validity analysis by using CFA could be seen from t-value, and conten factor could be seen from alpha value. If the alpha value was >0,03 (significantly 5%) compared to table t-value 1,96, the item could be said valid. If the alpha value was written in red, the item could be said invalid so it should be changed or not be used.

Appropriateness test model could be seen from RMSEA which had to be lower than 0,8 and Goodness of Fit Index (GFI) which had to be higher than 0,90, Wijanto, 2008). Test appropriateness between theoritical and empirical models was based on four categories; (1) Chi-square, (2) Significant Probability, (3) Root Mean Aquare of Error Approximation (RMSEA), and Goodness of Fit Index (GFI), the standards used could be seen in Table 1.

The method of applying ABHS technology as a focus of STS program was described with its indicators in the following draft.

Whereas the methods of applying STS in ABHS activity to improve crop productivity were done as what Table 2 showed.

Table 1. Goodness of Fit Index

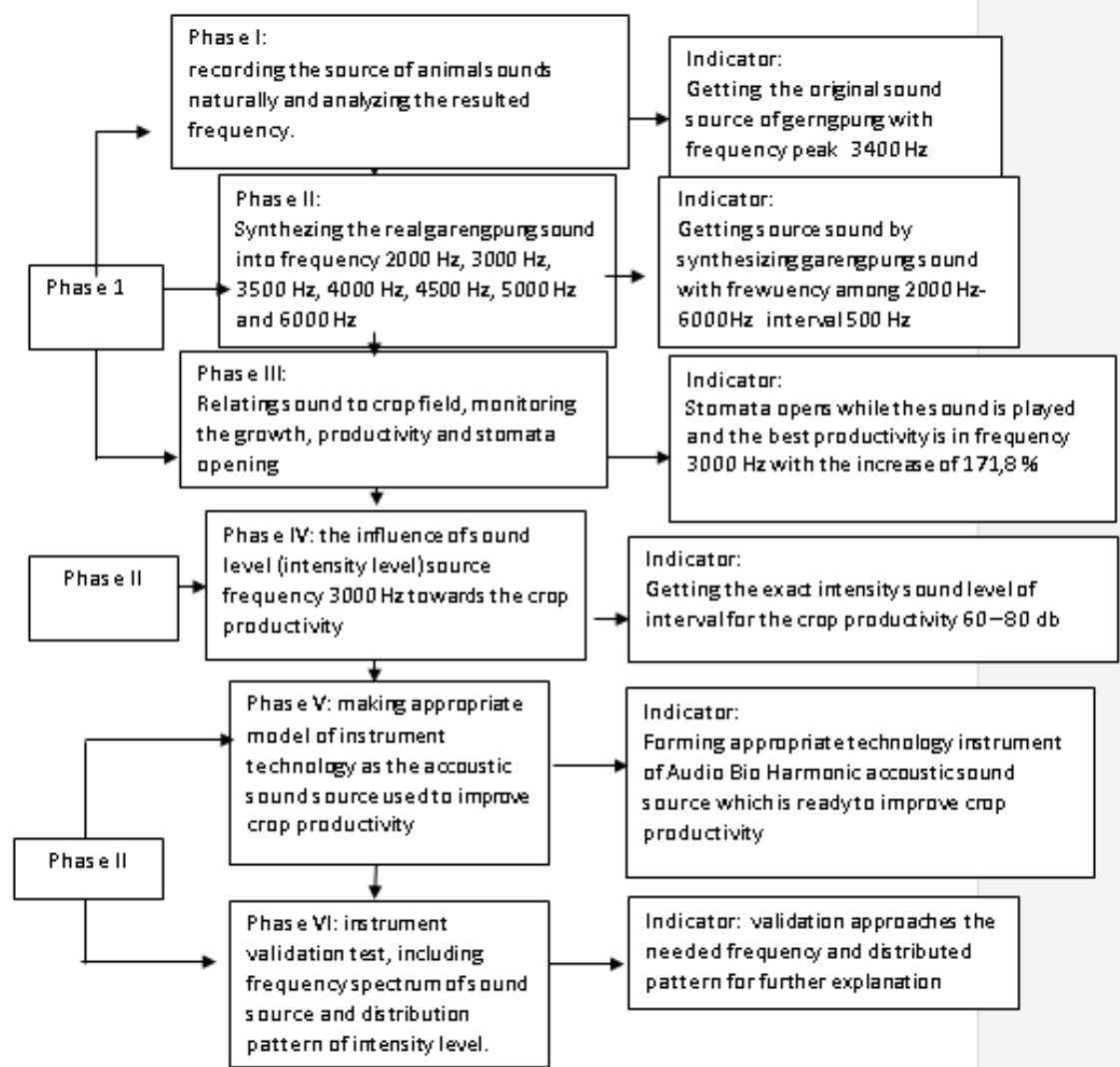| Index	Cut of value	explanation
Chi-Square (X2)	small	The smaller X2, the better
Probability (p)	$\geq 0,05$	Shoudl be higher than 0,05
RMSE	$\leq 0,08$	Average difference
Goodness of Fit Index (GFI)	$\geq 0,90$	The value approximately 0-1

Figure 2. Steps of applying ABHS technology

RESULTS AND DISCUSSION

Model of CIPP evaluation in STS learning program was developed in order to be used to evaluate the application of ABHS in improving crop productivity. The previous research result showed that learning in local society environment, like the case of National Baluran Park, could improve students learning achievement including creative thinking skill (Putra & Iqbal, 2016).

Steps description of developing evaluation model could be systematically and practically used by a lecturer to evaluate the program integrated with the community service program. The development was begun with theoritical study, first observation or need analysis, and empirical findings on the field so that the first draft of evaluation model development could be designed. The first draft was then criticized by soem experts tho-

rugh Delphi techniqueconsisting of researcher team or community service program team and other lecturers who were considered as experts in evaluation field. The result of Delphi made components from the first draft change in many ways especially in the content of evaluation context, composition, instrument amount, STS evaluation program component, the format of writing insruction in instrument column, and linguistic contruction problem.

When validating the content of first STS evaluation model program in applying ABHS by researchers and evaluation experts, Focus Group Discussion (FGD) was done at the same time. The result of FGD was determining evaluation standard in STS applying ABHS which consisted of program context, program input, program process, and program product. The agreement result of FGD became the standard to evaluate STS

Table 2. Model syntax of STS learning to apply ABHS

Phases of STS learning	Teaching activity/field activity
Phase 1 (Invitation) • Digging issue or problem by students • Connecting newe learning with th eprevious learning • Identifying issue or problem in society which is related to the discussed topic	• Lecturer asks some effective questions so that the students are motivated to learb biophysics applying ABHS to improve vrop productivity • The lecturer gives a prositive response to the students trying to answer • The lecturer explains main material and practical benefit that will be got
Phase 2 (Exploration) • Designing and doing experiment or test to collect data • Training science process skill • Sharpening scientific work and scientific attitude • Discussing in group to take the conclusion	• The lecturer divides students into some groups • The lecturer guides students doing experiment about applying ABHS together with Tani Ngudi Luhur and Tani Ngudi makmur groups to explain and solve the problem, then report the observation result to be concluded
Phase 3 (proposing explanation and solution) • Students build the concept by themselves • Students discuss • Solution to the problem faced by society	• The lecturer directly invites students to discuss the result then it is applied in other situation • The lecturer pays attention to the result of all activities done by groups • The lecturer re-observes students' activities if there is a group giving unclear conclusion
Phase 4 feedback • Explaining the phenomena of productivity improvement naturally with animal sound stimulant based on the organized concept • Explaining some application to give meaning • Concept understanding reflection	• The lecturer gives summary or brief explanation about the right concepts among students • The lecturer asks a question which is conceptual.

(Modified from Yager, 1992)

program in apllying ABHS in three farming fields which were tested.

The practice of evaluating STS program in applying ABHS exactly used the model following component standards decided by evaluation standard from FGD result. This evaluation model component had been tested many times and repaired so that it became the appropriate model to be used for STS program in applying ABHS. The technique used to analyze the data was descriptive analysis by using the average score and total average score to be then confirmed with convertion standard by using criteria that had been agreed.

The result of context evaluation of STS program applying ABHS consisting of the description of crop comodity kind and field which was appropriate with program context, program need, and a chance for students to do this program had been "very good'. Input evaluation consisting of field quality, seed quality, and ABHS equipment, was evaluated by farmers and students, had a "very good" category because the practice of input was very selective whether in preparing ABHS edia with solar energy, traing students, and traing farmers to support the success of STS in applying ABHS with solar energy. The result of process evaluation in STS program appliying ABHS was "very good." Students had done very maximally, farmers worked profesionally, when applying ABHS with solar energy the farmers also did independently.

The result of process evaluation from observation during students training had 0,69 value of "reliability" which was "good" and the observation result during farmers training was 0,72 balue of "reliability" which was also "good." Observation process was tarted with looking at students presentation and discussion about concept and technique in applying ABHS to improve crop productivity. Observation process was also done by looking at farmers doring parctice and discus-

sion about technique to apply ABHS to improve crop productivity.

The observation result showed that STS learning media which was ABHS with solar energy, had been used very well and maximal, wither by students (0,86) or farmers (0,89). Students motivation (0,89) and farmers motivation (0,88) in training activity of applying ABHS to improve crop productivity had high ebthusiastic, it was seen from the result of assessment evaluation which was considered as "very good" category. ABHS was applied during photosynthesis, because it had a big role in photosynthesis, carbohidrate transportation, forming protein, balancing ion, regulating plant stomata and activating plant enzim water use and another process (El-Sawy et al., 2008; El-Tantawy, 2009).

The motivation in training to apply ABHS as a plant growth stimulant and crop productivity evenly came form training participants themselves, it was completed with documentation data about the success of applying ABHS in some locations that were tested. The technique of applying ABHS in some kind of plants (corn, chili, and onion) was good enough. Applying ABHS caused the plants optimally consume nutrition through the air which had many substances needed by plants. The highest result was got in anorganic since there were many nutrients during fertilizing leaves. The lowest result was caused by the lack of nitrogent which caused the lack of productivity (Shangguan et al., 2000, Lawlor, 2002). To keep the quality of ABHS implementation in farmers, they were guided continously by students. The guidance also became instrument data.
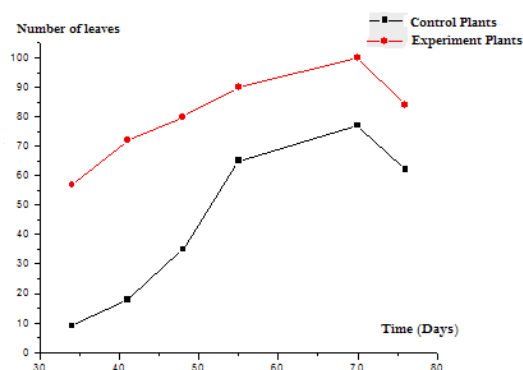

Figure 3. Chart of leaf growth (every 10 days)

Product evaluation in this research focused on two aspects, first was students' improment skill and farmers in using ABHS, and second was crop productivity; (1) chile reached to 76,4%, (2)

onion reached to 56,3%, and (3) corn reached to 67,8%. Besides, the influenmce of implementing ABHS towards plant growht was inspected as it was seen in the following chart, which compared plabt growth given ABHS treatment (experiment group) and not given (control group).

From the chart, there was a better significant growth from experiment plant given treatment by ABHS technology of solar energy than farmers competence in applying ABHS with solar energy; all were indicators arranged from the result of developed evaluation model.

The developed evaluation model had been tested empirically, and it fulfilled Goodness Fit Index criteria using Confirmatory Factor Analysis (CFA). The instrument of result development had validity > 0,3 and reliablity >0,70. So, the instrument of developed evaluation model could be used to evaluate STS program i applying ABHS in farming fields belonging to Tani Ngudi Makmur and Tani Ngusi Luhur groups at Kedungsari village, Pengasih subdistrict. Evaluation component and STS indicators in applying ABHS with solar energy had successfully been organized in systematic. The model used to evaluate STS program in applityng ABHS with solar energy was CIPP model. This model evaluated STS in applying ABHS with solar energy by using components from CIPP which were context, input, process, and product. The analysis result of components and indicators of evaluating STS program in applying ABHS with solar energy was tested empirically to get valid and reliable criteria for instrument constructs and test model which was hypothesized by using the test result in the field.

CONCLUSION

The result of this research was the success of STS approach done at science education program, Yogyakarta State University, which had been evaluated through CIPP model (Context, Input, Process, and Product). This model was choosen because the quality of learning result through STS approach (Science Technology and Society) was influenced by input, process, and product. The process assessment result from observation during students' training had 0,69 value "good reliability" and during farmers' training had 0,72 value "good reliability." The process of observation was started with seeing students presentation and discussion about the concept and technique of implementing ABHS to improve crop productivity. Observation process was

also done by seeing farmers during the practice and discussion of the technique of implementing ABHS to improve crop productivity.

The result of CIPP evaluation in this research had two aspects, first was improving students' skill and farmers' skill in using ABHS, and second was crop productivity; (1) chili reached 76,4%. (2) red onion increased to 56,3%, and (3) corn increased to 67,8%. There was significant influence from applying ABHS towards plant growth. The outcome of this research was integrated science learning material with STS approach and appropriate technology of ABHS with solar energy.

The result of this research is highly recommended by lecturer and science teacher to improve learning based research like applying ABHS with STS approach, so there is an integration between physics and biology concepts. STS approach is suggested because society really needs scientist contribution in science in solving a problem related to using technology in the field in many life activities.

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REFERENCES

Akcay, Behiye, & Akcay, Hakan. 2015. Effectiveness of Science-Technology-Society (STS) Instruction on Student Understanding of the Nature of Science and Attitudes toward Science. International Journal of Education in Mathematics, Science, and Technology, 3 (1), 37-45.

Altieri, M. A. (1999). The ecological role of biodiversity in agroecosystems. *Agriculture, ecosystems & environment*, *74*(1), 19-31.

Bakar Elif, Senol Bal, & Akcay Hakan. 2006. Preservice science teachers beliefs about science –technology And their implication in society. Eurasia Journal of Mathematics, Science and Technology Education. 2 (3), 18-32.

Butin, D. W. (2003). Of what use is it? Multiple conceptualizations of service learning within education. *Teachers College Record*, *105*(9), 1674-1692.

Daryanto, H. (2008). Evaluasi pendidikan. *Jakarta: PT Rineka Cipta*.

Donald, P. F., Green, R. E., & Heath, M. F. (2001). Agricultural intensification and the collapse of Europe's farmland bird populations. *Proceedings of the Royal Society of London B: Biological Sciences*, *268*(1462), 25-29.

The driver, R., Leach, J., Miller, R., & Scott, P. 2000. Young people's images of science. *Buckingham: Open University Press*.

El-Sawy, B. I., Radawan, E. A., & Hassan, N. A. (2000). Growth and yield of potato as affected by soil and foliar potassium application. *J. Agric. Sci. Mansoura Univ*, *25*(9), 5843-5850.

El-Tantawy, I. M., El-Ghamry, A. M., & Habib, A. H. (2009). Effect of chicken manure and manure compost tea on potato yield and soil fertility. *J. Agric. Sci*, *34*, 659-668.

Gelmon, S. B. 2000. Challenges in assessing service-learning. Michigan Journal of Community Service Learning, Special Issue, 84–90.

Ghozali, Imam. 2008. Model Persamaan Struktural Konsep dan Aplikasi dengan. Program Amos 16.0. Badan Penerbit UNDIP. Semarang.

Holland, B. A. (2001). A Comprehensive Model for Assessing Service-Learning and Community-University Partnerships. *New Directions for Higher Education*, *2001*(114), 51-60.

Isaac, S., & Michael, W. B. (1971). Handbook in research and evaluation.

Karayan, S., & Gathercoal, P. (2005). Assessing service-learning in teacher education. *Teacher Education Quarterly*, *32*(3), 79-92.

Koliba, C. J., Campbell, E. K., & Shapiro, C. (2006). The practice of service learning in local school-community contexts. *Educational Policy*, *20*(5), 683-717.

Lawlor, D. W. (2002). Carbon and nitrogen assimilation in relation to yield: mechanisms are the key to understanding production systems. *Journal of experimental Botany*, *53*(370), 773-787.

Lewis, T., & Dibley, G. C. (1970). Air movement near windbreaks and a hypothesis of the mechanism of the accumulation of airborne insects. *Annals of Applied Biology*, *66*(3), 477-484.

Lewis, T., & Stephenson, J. W. (1966). The permeability of artificial windbreaks and the distribution of flying insects in the leeward sheltered zone. *Annals of Applied Biology*, *58*(3), 355-363.

Mabry, J. B. (1998). Pedagogical Variations in Service-Learning and Student Outcomes: How Time, Contact, and Reflection Matter. *Michigan Journal of Community Service Learning*, *5*, 32-47.

Mickleburgh, S. P., Hutson, A. M., & Racey, P. A. (2002). A review of the global conservation status of bats. *Oryx*, *36*(01), 18-34.

Moore, D. T. (1999). Behind the wizard's curtain: A challenge to the true believer. *NSEE Quarterly*, *25*(1), 1.

Nurosis, J. M. (1986). SPSS/PC+ for the imbbc/xt/at.

Connor, O. RJ & Shrubb, M. 1986. Farming and Birds.

Prabowo, S. A. (2015). The effectiveness of scientific based learning towards science process skill mastery of PGSD students. *Jurnal Pendidikan IPA Indonesia*, *4*(1), 15-19.

Putra, P. D. A., & Iqbal, M. (2016). Implementation of serious games inspired by baluran national

park to improve students'critical thinking ability. *Jurnal Pendidikan IPA Indonesia*, *5*(1), 101-108.

Shangguan, Z., Shao, M., & Dyckmans, J. (2000). Effects of nitrogen nutrition and water deficit on net photosynthetic rate and chlorophyll fluorescence in winter wheat. *Journal of Plant Physiology*, *156*(1), 46-51.

Sofowora, O. A., & Adekomi, B. (2012). Improving science, technology and mathematics education in Nigeria: A case study of Obafemi Awolowo University, Ile-Ife. *African Journal of Educational Studies in Mathematics and Sciences*, *10*(1), 1-8.

Steinke, P., & Buresh, S. (2002). Cognitive outcomes of service-learning: Reviewing the past and glimpsing the future. *Michigan Journal of Community Service Learning*, *8*(2), 5.

Stufflebeam, D. L. (1971). The use of experimental design in educational evaluation. *Journal of Educational Measurement*, *8*(4), 267-274.

Stufflebeam, D. L, Shinkfield, A. J. 1985. Systematic evalaution. U.S.A. Massachu-setts: Kluwer-Nijhoff Publishing.

Sugiyono, M. P. K. (2008). kualitatif dan R&D. *Bandung: Alfabeta*, *124*.

Verboom, B., & Spoelstra, K. (1999). Effects of food abundance and wind on the use of tree lines by an insectivorous bat, Pipistrellus pipistrellus. *Canadian Journal of Zoology*, *77*(9), 1393-1401.

Rosana, D. (2014). Pengembangan Soft Skills Mahasiswa Program Kelas Internasional melalui Pembelajaran Berbasis Konteks untuk Menin-

gkatkan Kualitas Proses dan Hasil Belajar Mekanika. *Jurnal Pendidikan IPA Indonesia*, *3*(1).

Arikunto, S., & Jabar, C. S. A. (2011). Evaluasi program pendidikan.

Wijayanti, A., & Basyar, M. A. K. (2016). The development of thematic–integrated e-portfolio media web blog based to increase the scientific literacy of elementary teacher education program's student. *Jurnal Pendidikan IPA Indonesia*, *5*(2).

Wijanto, S.H. 2008. Struktural equation modeling dengan lisrel 8. *Yogyakarta: Graha Ilmu*

Worthen, B.R & Sanders, J.R. 1981. Educa-tional Evaluation: Theory and practice. *Ohio: Charles A. Jones Publishing Company Worthington.*

Yager, R. E. (1992). The STS approach parallels constructivist practices. *Science Education International*, *3*(2), 18-20.

Yulianto, Y. (2012). Penerapan teknologi sonic bloom dan pupuk organik untuk peningkatan produksi bawang merah (Studi Kasus Bawang Merah di Brebes, Jawa Tengah). *AGROLAND*, *15*(3).

Zhang, G., Zeller, N., Griffith, R., Metcalf, D., Williams, J., Shea, C., & Misulis, K. (2011). Using the Context, Input, Process, and Product Evaluation Model (CIPP) as a Comprehensive Framework to Guide the Planning, Implementation, and Assessment of Service-Learning Programs. *Journal of Higher Education Outreach and Engagement*, *15*(4), 57-84.

Zoller, U. (2012). Science education for global sustainability: What is necessary for teaching, learning, and assessment strategies?.