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SETS BEST PRACTICE MODEL: GROWTH OPTIMIZATION AND PRODUCTIVITY OF ORGANIC FOOD PLANTS THROUGH IASMUSPEC APPLICATION

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ABSTRACT

The application of SETS (Science, Technology, Environment, and Society) approach through the Biophysics course has been proven as an effective solution to develop new literacy among students of Natural Sciences Study Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta. The application of this approach can solve the students' learning difficulties in connecting SETS elements within learning by providing integrated technology that is in line with basic competencies and learning indicators. The relational model of Integrated Audio Stimulator - Multi-Sensor - Pest Control (IASMUSPEC) engineering to optimize the growth and productivity of organic food plants directly involve students in practical science learning by applying technology to assist farmers. The method to produce SETS best practice model was the combination of Research & Development of spiral model referring to Cennamo and Kalk concept (2018) and Experimental Research for implementing IASMUSPEC to increase organic food plants productivity. A preliminary study of this research results in two aspects. They are the skills improvement aspect for both students and farmers in applying IASMUSPEC, and the increase of productivity aspect in organic rice plants into 209.81% (yield total for land samples of 8.3 x 29.8 meters) in the treatment plants was 237.3 kg, with and for control plants was 113.1 kg respectively. The effects of IASMUSPEC on plant growth rates were also examined. The output of this study was the subject-specific pedagogic (SSP) of Biophysics with SETS approach and IASMUSPEC appropriate technology.

Keywords: SETS, IASMUSPEC, organic food plants

INTRODUCTION

Disruption era that marks as the industrial revolution 4.0 has occurred where the world of the digital industry has become a trigger for the emergence of a new paradigm and reference for current order of life. Industry 4.0 is a promising approach based on the integration of the business and manufacturing processes, as well as the integration of all actors in the company's value chain (suppliers and customers). Technical aspects of these requirements are addressed by the application of the generic concepts of Cyber-Physical Systems (CPS) and Internet of Things (IoT) to the industrial production systems (Rojko, 2017). These developments are reconfigurable manufac-

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turing systems that could adapt their hardware and software components to follow ever-changing market requirements of product type and quantity (Korena & Shpitalnib, 2010; Nayak et al., 2015). To anticipate this era, new literacy, including human literacy, digital technology literacy, and data literacy, is genuinely needed in which education becomes the primary catalyst. Human literacy is oriented towards the growth of positive characters to shape creative, innovative, and adaptive graduates with current changes. Data of literacy refer to the development of reading skill, analyzing and drawing conclusions based on data and information (big data) as part of strategic decision-making. Besides, technology literacy is related to the ability to implement technology as a means for people's prosperity.

Dealing with this current development, SETS (Science, Environment, Technology, and Society) utilize Science in forming technology to meet the needs of the society through the implications in the physical and mental environment. SETS are the terms that indicate teaching reform to provide those industrial revolution 4.0 requirements (Driver et al., 2000). The application of this approach in science learning has been known for quite a long time (The NSTA Position Statement, 2015), yet the main problem is on students' difficulties to connect SETS elements within learning because of the absence of integrated technology that is in line with basic competencies and learning indicators. Therefore, it urges the provision of a relational model, such as Integrated Audio Stimulator - Multi-Sensor - Pest Control (IASMUSPEC) engineering to optimize the growth and productivity of organic food plants in science learning. The application of SETS model is proven to increase students' understanding, logical thinking, and mental cycles (Yörük et al., 2010). Nowadays, the application of SETS approach is very relevant since the world of education begins to realize to produce graduates who can adapt to a technology-oriented economy among society (Sofowora & Adekomi, 2012). Students who experienced SETS approach perform better than students enrolled in section where traditional methods in terms of: (1) student understanding of scientific process; (2) student ability to apply scientific concepts related to science and technology; (3) positive attitudes; and (4) better creativity skills (Akcay & Yager, 2010). Similarly, the SETS learning model shows a better impact on students' understanding in secondary level for the nature of science and attitudes towards science compared to the students taught by the same teacher using the traditional approach which is oriented to textbook instructions (Akcay & Akcay, 2015). In other relevant studies about SETS, it is explained that the implementation of thematic learning of SETS integrated with local wisdom was able to reconstruct and increase the disaster management knowledge (Atmojo et al., 2018).

The developed SETS best practice model in this study is not just a written concept, but something real that can be understood, sensed, analyzed, and an alternative of a solution to problems. This learning model also simultaneously increases the relevance between theory and application in the form of IASMUSPEC to increase the productivity of organic plants. The connection between learning and real-life matter proves that SETS approach is teaching and learning of science and technology in human experience context. Students do learn not only the theory of natural science but also examine the real-life situations related to the theory. This will have a positive impact on the development of student competence (Anggraeni et al., 2013; Pedretti et al., 2008). Based on the perspective of SETS program sustainability, relevant knowledge that can be included in the program must be guided by ideas and social responsibility. This condition requires a new type of education with intentional awareness to be oriented on literacy (Zoller, 2012).

The purpose of implementing SETS in this study is to help students to be able to connect between learning with relevant technology based on Internet of Things (IoT). SETS best practice model produces learning that can provide basic skills among students for their development as human beings, community members, and citizens, to be ready for their further education level. The learning theory used in SETS approach is constructivism, behaviorism, cognitive development, and social cognitive. The syntax of the SETS learning used in this study is presented in Figure 1.

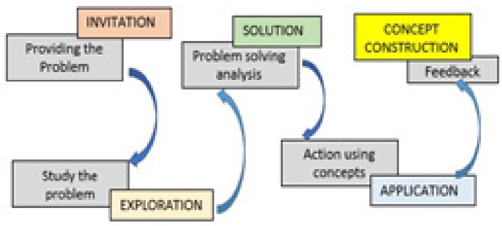


Figure 1. The Syntax of SETS Learning

The use of microcontroller technology (embedded systems) in IASMUSPEC for agriculture both as the tool and the process is still extensive and open. The real-time information about important parameters which have a significant effect on the quality of plants growth, such as conditions of soil moisture, air humidity, air temperature, light intensity, and others, will significantly help farmers to know the actual conditions of plant growth and its environmental conditions. Besides, this device is also equipped with rat repellents and leafhoppers by using sound exposure as its working principle. As the demands of the disruption era for new literacy development, IASMUSPEC also implements the Internet of Things (IoT) concept where the parameter data as the output of the sensor readings are sent to the cloud. This online and real-time information can help farmers to take the right steps and decisions for fertilization, irrigation, and the like. The block diagram of the IASMUSPEC device applied in science learning can be seen in Figure 2 below.

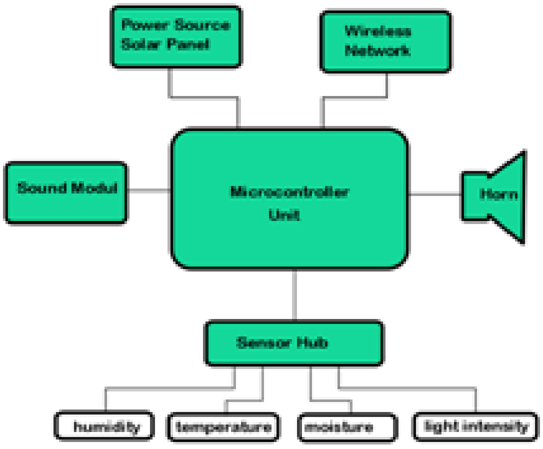


Figure 2. Diagram Block of Intergrated Audio Stimulator - Multi Sensor - Pest Control (IASMUSPEC)

The designed IASMUSPEC tool in this study was made more compatible, comprehensive, and based on microcontroller technology (embedded systems). It is also completed with solar energy as the response to previous problems, i.e., electrical unavailability in agricultural areas (it could be used in remote areas). The technology to optimize audio intensity variables is also installed, i.e. the optimum frequency and intensity to control pests and, at the same time, produce plants that are able to optimally absorb nutrients and solar energy to create "greedy" plants for the sake of increasing productivity and quality (Rosana et al., 2017). The results of the research with ABHS (Audio Bio Harmonic System) tool have been able to increase the productivity of potato plants (87%), and shallots (57%).

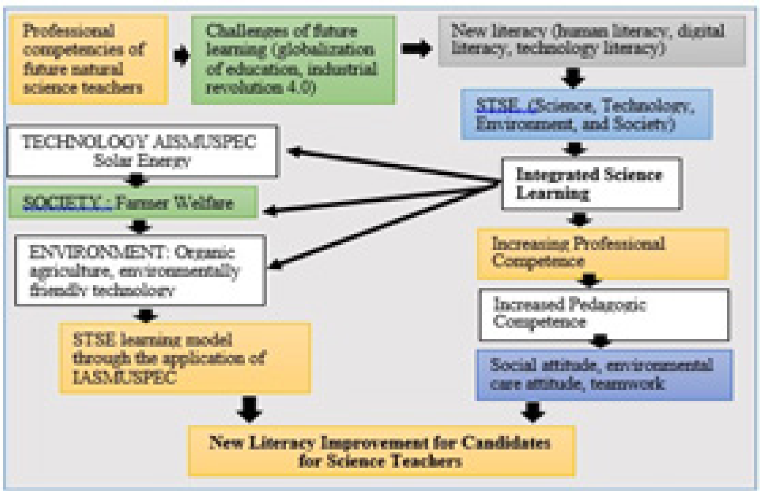


Figure 3. Research Paradigm

METHODS

The research methodology to produce SETS best practice model is a combination of Research & Development of spiral model referring to Cennamo and Kalk concept (2018) and experimental research for IASMUSPEC implementation to increase organic food plants productivity. In this spiral model, the 5 (five) phases of development are define, design, demonstrate, develop, and deliver. Meanwhile, the experimental study for the tool application utilized the sound of Garengpung (*Dundubia manifera*) manipulated at 4000 Hz frequency peak and validated using the Octave 4.2.1 program. The studied plants were rice (*Oryza sativa*) in a horizontal field. The observed data included the growth of rice plants (plant height, number of tillers, and seedlings in one clump). Further, the area of stomata openings were observed using the light microscope while its output was examined using the NIS Elements Viewer program. The area was measured using Figure Raster 3.0, while rice productivity in the form of mass was analyzed employing Origin 8.0 and Microsoft Excel 2013. The sound intensity levels were examined using a sound level meter.

The application of SETS model in the experimental class (31 students) and the control class (30 students) involved second-semester students who joined Biophysics course in Natural Science Education Study Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta in the academic year of 2018/2019. For each R & D stage, the data collection was done through product validation instruments in the form of IASMUSPEC model and engineering results, observation, interviews, questionnaires, performance evaluation sheets, students' attitudes and learning outcomes of Biophysics learning. The observations and interviews were prepared as the need analysis of the developed model. Moreover, the questionnaires consisted of two types, validation, and practical questionnaire.

Table 1. The Need Analysis of New Literacy Measurements

No	Variable	Average Value (Scale of 5)	Explanation
1	*Technology Literacy*	2,45	Poor
2	*Data Literacy*	2,24	Poor
3	*Human Literacy*	2,35	Poor

The validation sheet was examined by the experts of learning model design, learning media, and construction (content and language). After the IASMUSPEC model and tools were theoretically valid, the model was tested empirically using one to one evaluation method. The evaluation results were tested again in a small group and field test evaluation to find out the practicality of the model. During the application of IASMUSPEC model and tools, either in learning or implementation activities with farmer group partners, the researchers took notes through the observation sheet to obtain data on the development of new literacy (human literacy, digital technology literacy, and data literacy) through SETS application in case of cognitive, affective, and performance assessment. Furthermore, data regarding the students learning outcomes of new literacy were obtained through tests and non-tests. On the other hand, learning outcomes in the form of performance were carried out through student portfolios. The collected data from various instruments were analyzed descriptively, quantitatively, and qualitatively.

Table 2. Reserach Procedure

Steps	Activities
Define	Conducting need analysis, formulation of conceptual definitions of IASMUSPEC engineering for SETS model to prepare pre-service teachers' new literacy
Design	Designing practical and effective products and validation instruments
	Validating model and tool guidance through tests
Demonstrate	The model was tested empirically using *one to one evaluation* method
Develop	Implementing IASMUSPEC model and tools as well as carrying out practicality and effectiveness tests One to one Small group Field group
Deliver	Assessing the formative and summative use of the model
	Final Packaging of IASMUSPEC
	Describing how the diffusion process of IASMUSPEC model products and devices

The data of this study consisted of the experimental data from IASMUSPEC application to increase rice crop productivity and the data on the assessment of processes and student learning outcomes for the implementation of SETS models, especially in the new literacy aspect. The obtained data were divided into two, namely, qualitative and quantitative. The quantitative data were analyzed through Exploratory Factor Analysis (EFA) with the help of SPSS 20.0 program. The construct validity was tested by reviewing the value of Kaiser Mayer Olkin (KMO) expected to be 0.5 (> 0.5). Besides, EFA was also employed to test the second trial's validity as well as construct the test normality before CFA analysis in the third trial. The reliability of the measurement data can be seen from the alphabet value if the alpha value is > 0.7, so the instrument is considered reliable and if alpha <0.7, it is considered unreliable.

Testing with Cronbach Alpha was to examine the reliability of the instrument during the trials. The results of the experiments were then analyzed using the CFA method to know the validity of each instrument, i.e., context, input, process, and product. The validity analysis using CFA can be seen from the value of t (t-value), and the factor load was from the alpha value. If the alpha value is > 0.03 (significant level of 5%) compared to the cost of t table 1.96, then the item is declared valid. The validity can be proven in the path diagram indicated by black numbers, the bigger the value of t count, the more valid the item will be. If the alpha value is written in red, it means that the item is invalid so it must be replaced or omitted.

Table 3. Digital Technology Literacy Indicator

No	Indicators	Sub Indicators	Number of Item
1	Internet searching	The ability to use a web browser such as Google Chrome, Mozilla Firefox, Internet Explorer to search and download	1,12
		The ability to use the Internet including the World Wide Web (www) to search for a broad collection of information.	2,13
		Ability to use online databases (Proquest, Ebsco, Scopus, PubMed and other databases)	3,14
2	Hypertextual navigation	Technical skills in information retrieval such as Boolean techniques "or", "and" and "not"	4,15
		Ability to use information retrieval system tools where digital libraries currently use online access	5,16
		The ability to evaluate information presented on the internet critically, to determine the information relevant to user needs	6,17
3	Content evaluation	The ability to utilize information provided to users after selecting the information needed	7,18
		The ability to evaluate information presented on the internet critically, to determine which information is relevant to user needs	8,19
4	Knowledge assembly	The ability to create communication such as fila makers using media such as images, videos, and sounds	9,20
		The ability to create communication through digital media such as social network design, blog design or gmail,	10,21
		The ability to create content and effective communication using a variety of digital media tools, such as creating an online portal	11,22

Table 4. Data Literacy Indicator

No	Indicators	Sub Indicators	Number of Item
1	Read data skills	Tabulating data systematically	1,12
		Classifying data with certain characteristics	2,13
		Using primary or secondary data	3,14
2	Data analysis skills	Data analysis techniques skills	4,15
		Analyzing data correctly using appropriate analytical techniques	5,16
		Evaluating data critically to determine the relevant information	6,17

3	Skills to utilize data in experimental activities	Understanding how existing data are used in answering problems in experiments	7,18
		Evaluating the data presented so that it is suitable for the purpose of the experiment / learning	8,19
4	Data communication skills	Creating communication using media such as tables, graphs, charts, etc.	9,20
		Creating communication through written media in the form of lab reports,	10,21
		Presenting research results	11,22

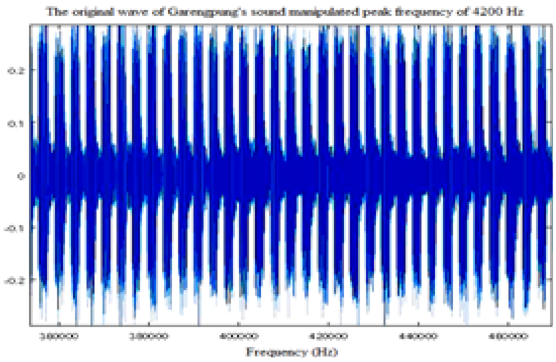
To test the compatibility of the model based on RMSEA, it must be below 0.08, and the Goodness of Fit Index (GFI) must be bigger than 0.90, (Wijanto, 2008). The tests of compatibility between theoretical and empirical models were based on four categories: (1) Chi-Square; (2) Significant Probability; (3) Root Mean Square of Error Ap-proximation (RMSEA); and (4) Goodness of Fit Index (GFI). Those standards can be seen in Table 5 below.

Table 5. Goodness of Fit Index

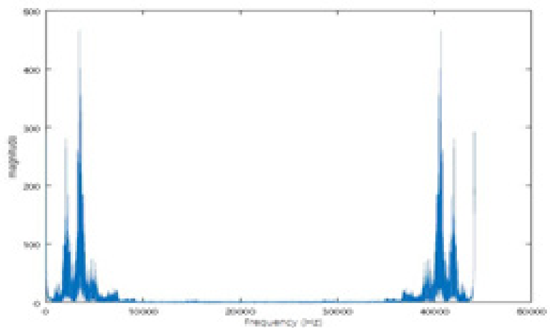
No	Index	Cut of Value	Explanation
1	*Chi-Square* (*X2*)	Small	The smaller of the X2 is the better
2	*Probability* (p)	≥ 0.05	Mst be bigger than 0,05
3	*RMSE*	≤ 0.08	Mean difference/df
4	*Goodness of Fit Index (GFI)*	≥ 0.90	Score range 0-1

RESULTS AND DISCUSSION

The research on the IASMUSPEC application to increase rice productivity made use of Garengpung (*Dundubia manifera*) sound. The original sound of Garengpung at a peak frequency of 3000 Hz was manipulated to 4000 Hz frequency. The floating sound wave was at a peak frequency of 4000 Hz inserted in the Octave 4.21 software in which the obtained wave shown in Figure 4a. The Y-axis was the frequency, and the Y-axis was the mangrove, Octave 4.21 was also used to analyze its peak frequency. The signal spectrum is shown in Figure 4b.



(4a)

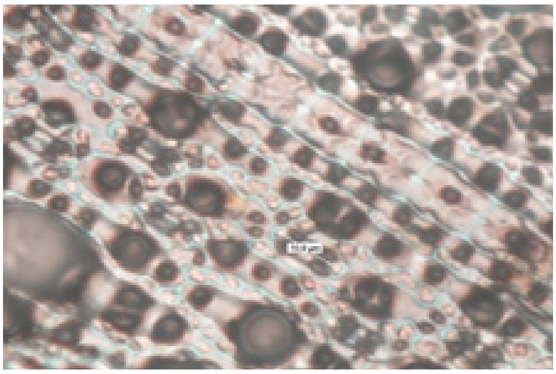


(4b)

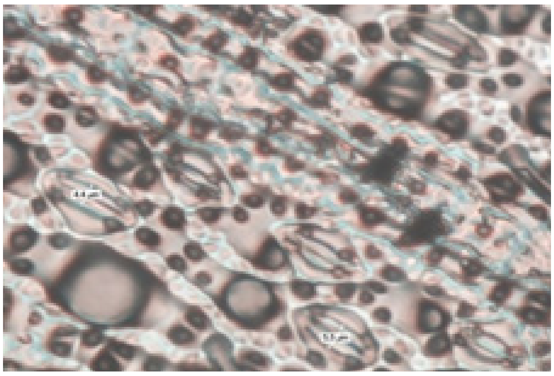
Figure 4. The wave shape of Garengpung sound at peak frequency of 4000 Hz

The working mechanism of IASMUSPEC is to stimulate the opening of leaf stomata by disturbing vibrations from the sound waves of Garengpung during photosynthesis. The sound vibration will move energy to the leaf surface and stimulate the leaf stomata to open wider (Nur Kadarisman et al., 2011). Through this research, it was revealed that the exposure of Garengpung sound that was manipulated at the peak frequency of 4000 Hz influenced the leaf stomata openings on the rice plants. The following is the Figure of leaf stomata in the rice plants openings by using an electron microscope. Figure 5a was captured before given a sound exposure from IAS-

MUSPEC and 5b was when the sound exposure was given.



(5a)



(5b)

Figure 5. Examples of Stomata Pictures Before Being Exposed to Sound and When Exposed to Sounds from IASMUSPEC: (a) Before the Sound Exposure and (b) When the Sound Exposure is Given

The research results on the data of leaf stomata in rice plants (*Oryza sativa*) when given sound exposure of Garengung manipulated at a peak frequency of 4000 Hz are presented in Table 6.

Table 6. The Average Data of the Leaf Stomata Openings in Rice Plants

The Average of Stomata Openings Width (μm^2)		
Before	During	After
32.96	44.79	35.81

There were differences in the width of the stomata openings before and after the exposure of Garengpung sounds. The average value of the stomata opening area during sound exposure was more significant than before and after the sound exposure. The average width of stomata openings before treatment was 32.96 μm2, during the treatment was 44.79 μm2, and after the treatment was 35.81 μm2, respectively.

Stomata function as the exchange regulator of various gases needed regularly in the inner parts of plants. When the cross-section of the stomata opening getting wider due to the sound exposure, it helps the plants to absorb nutrients optimally, especially during the photosynthesis process. These movements came from the guard cells that were able to changes their form as they had "elastic" cell walls (Sutrian, 2011). Stomata opened because guard cells take water and bulge where bulging guard cells pushed the inner wall of the stomata close together. Stomata worked by their way due to the unique nature of the submicroscopic anatomy of the cell wall. Guard cells could increase in length, especially the outer wall, to expand outward. The inner wall was then attracted by the microfibrils that resulted in the opening of the stomata (Abersheim et al., 2010). The largest stomata opening in leaves was found during 09.00 - 10.00 WIB, while and the smallest width of stomata porous was at 12.00 WIB. (Fatonah et al., 2013).

Application results of SETS Model in Science Learning

The development of the SETS model began with a conceptual definition analysis on the variables of science learning, need analysis, and empirical findings in classroom learning. The results of this conceptual analysis were then upgraded to an operational definition in the form of SETS model draft with the use of IASMUSPEC for organic agriculture. The initial draft was later criticized by experts through a Delphi technique consisting of the researchers and the experts of the evaluation field. The results of Delphi made the components of the initial draft experienced a lot of revision; especially the contents of the evaluation context component, the structure of learning activities, the types of learning instruments, the composition of SETS model, the accuracy between the model and the learning characteristics, the format of instructions writing in the instrument column, and the language instruction.

The contents validation process for the initial draft of the SETS program evaluation model was carried out simultaneously with the Focus Group Discussion (FGD). Based on the FGD results, the basic standards for SETS model evaluation of IASMUSPEC application should consist of contexts, inputs, processes, and products from the model application in science learning. This theory is relevant to the results of research indicating that the course of science, environment, technology, and society can strengthen students 'characters and ecopreneurship (Martini et al., 2018).

The results of the context evaluation for SETS model with IASMUSPEC application were descriptions of the types of food crops that will be used as the object of experimentation, determination of affordable land, experiments requirements, and opportunities for college students to carry out IASMUSPEC implementation activities. The result based on the expert team's justification was "Very Good." The input evaluation consisted of the students' characteristics, the nature of Biophysics courses, and the features of IASMUSPEC tool, in which those were, categorized "Very Good" according to the expert team. The evaluation concluded that SETS model was "Very Good." The students worked optimally, and the farmers cultivated the land professionally. During the implementation of IASMUSPEC, the farmers could do it independently. The process evaluation results based on the observations during the classroom activities achieved a score of 0.78 and categorized as "Good" for the reliability level, and the observation results during the activities in the agricultural field obtained 0.81 and classified as "Good." The observation process was done by reviewing the students' presentation and discussion on the concepts and techniques of IASMUSPEC application to increase food crop productivity. The observation process was also carried out by examining the student activities when helping farmers for implementing IASMUSPEC to increase their rice productivity. IASMUSPEC was applied when photosynthesis took place as it has a crucial role in photosynthesis, carbohydrate transportation, protein formation, ion balance control, plant stomata regulation and activation of plant enzymes water use and other processes (Chaves et al. 2009; El-Tantawy, 2009). The observations showed that the SETS model in the form of IASMUSPEC application to increase organic plants productivity could be used very well and optimally, either by students (grades 0.87) or farmers (value 0.89). The student (score of 0.91) and farmers (score of 0.89) seemed to have high enthusiasm during the training activities of IASMUSPEC implementation. It can be seen from the evaluation results that can be categorized as "Very Good."

The implementation of IASMUSPEC for rice plants was going well as there is no significant technical obstacle. It was also supported by the farmers with their excellent cooperation. The use of IASMUSPEC resulted in optimal nutrients consumption by the plants by enlarging the extent of stomata openings. Hence, various beneficial substances can be optimally utilized by plants. In organic farming, the high of nutrients is needed during leaf fertilization, and the low supply of nitrogen for plants can decrease the crop productivity (Foley et al., 2011; Shangguan et al., 2000; Reguera et al., 2013; and Lawlor, 2002). To maintain the quality of the IASMUSPEC implementation for the farmers, continuous assistance should be provided by students who were also collecting data on the growth and yield of rice.

The product evaluation in IASMUSPEC application of SETS model refers to two aspects. Firstly, the skills development of students and farmers in using IASMUSPEC, and, secondly, the aspects of the case for increasing rice plants productivity. Based on the similar average field area between treatment and control plants, the treated plant clumps produced an average of 213.4 kg, while the control plants produced 122.6 kg. Thus, there was an increase of up to 174.06%, and the rate of plant growth increased significantly.

The application of SETS model in the form of outdoor learning system has succeeded in involving students in community services integrated into the curriculum (Furco & Root, 2010; Koliba et al., 2006). It is the answers for the challenges related to link and match between lecture materials and the form of community assistance (Setiyono, 2011; Gelmon, 2000; Prochaska et al., 1986). Such learning system requires an integrated approach so that a comprehensive assessment, evaluation, and reporting approach is needed to reveal its complexity (Molee et al., 2011; Gess-Newsome, 2013; Steinke & Buresh, 2002). The implementation of Research-based Physics Learning with SETS approach was effective in improving critical thinking skills and learning outcomes of the students (Usmeldi et al., 2017). This is parallel with Hairida (2017), who revealed that learning using SETS and local wisdom-based colloids teaching material was sufficient to improve entrepreneurial passion and concept understanding of students.

The measurement results of the improvement aspects for the students' new literacy showed changes that can be categorized as high for technology literacy, data literacy, and human literacy variables. Briefly, the measurement results of new literacy are displayed in Table 7 below.

Table 7. The Results of New Literacy Measurements

No	Variable	Gain score	Explanation
1	*Digitral Technology Literacy*	0.86	High
2	*Data Literacy*	0.68	Moderate
3	*Human Literacy*	0.59	Moderate

The SETS model with IASMUSPEC application to increase rice productivity had been empirically tested and had met the criteria of the Goodness of Fit Index through Confirmatory Factor Analysis (CFA). The instruments that support the model development had also been tested, which showed the validity> 0.30, and the reliability> 0.70; in other words, the developed SETS model tools can be used in research.

The results of IASMUSPEC application to increase Rice (*Oryza Sativa*) Productivity

The research on IASMUSPEC as a cheap and environmentally friendly stimulator of growth and productivity of rice plants is an alternative solution to overcome the problem of the food crisis that threatens the future world. This study used the sound of Garengpung (*Dundubia manifera*) manipulated at 4000 Hz frequency peak validated using Octave 4.2.1 program. The studied plants were rice (*Oryza sativa*) in the horizontal field of 8.3 x 29.8 meters. The harvest was carried out after the rice on the treated land was 102 days old, while, in the control land, it was carried out in 103 days old. This is in accordance with the average harvest time for the rice varieties of "menthik wangi" that is around 100 - 125 days. The measurement of plant productivity was done on the sample land with exposure of Garengpung sound manipulated at peak frequencies of 4000.

The overview of plant morphology also showed a significant difference between the experimental and the control land. The number of clumps in the sample area in the treated plants amounted to 1921 clusters, while in the control plant land were 1786. The measurement results of the rice harvest mass are presented in the form of tables and graphs that show the differences in yields between the treated and control plants. The productivity table and graph of crop yields per bed are presented below.

Table 8. Productivity of Rice Plants in the Field of 8.3 X 29.8 Meter

Beds	Treated Plants			Control Plants		
	Productivity (kg)	Number of Clumps of Rice Plants	Average of Productivity (gram)	Productivity (kg)	Number of Clumps of Rice Plants	Average of Productivity (gram)
1	48.5	315	164.2	25.6	305	77.3
2	32.7	302	98.1	21.7	322	35.5
3	32.6	283	111.1	17.3	321	58.2
4	42.2	275	162.0	18.4	318	63.7
5	32.2	296	104.4	15.1	327	48.4
6	49.1	315	156.1	25.0	328	77.3
Total	237.3	1786	799.9	113.1	1921	367.5

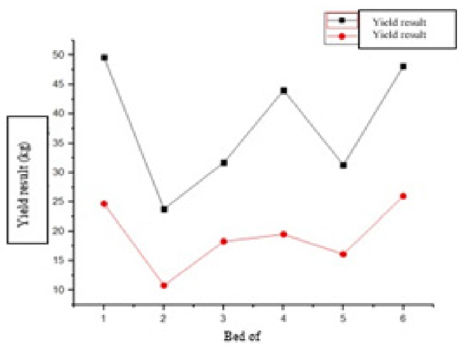


Figure 6. Graph of Crop Yield Mass Per Bed

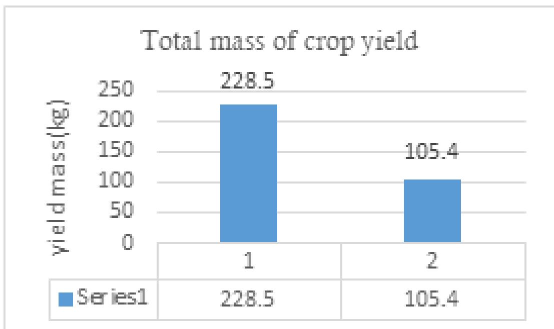


Figure 7. Comparison of Total Crop Yield

Based on Figure 6, it can be seen that the most abundant yield was found in the first bed with a total of 48.5 kg, and the average productivity per bed was 38.1 kg. From the above data, it can be concluded that the distance from the nearby sound source did not affect plant productivity.

As seen on Figure 7, it can be seen that the productivity of rice plants in experimental fields is better than the productivity of control plants. The total yield mass for land samples of 8.3 x 29.8 meters for the treated plants was 237.3 kg, while for the control plants were 113.1 kg. The factors that influence the mass of land treatment becomes better than the control plants is the difference in the number of stems in clumps, and it is quite significant.

From the graph, it can be seen that there was a significant difference between the rice plants in the experimental field and control land in terms of growth rates and yield productivity. This result strongly supports the efforts to increase food security by increasing the productivity of rice crops as the major food in Indonesia. This method is more effective than the agricultural intensification method that has been existed so far. The intensification, defined as an increase in agricultural commodity production per unit area (Tittonell, 2014), is made possible through increased mechanization and use of synthetic chemical fertilizers and pesticides (agricultural chemicals). However, it was done by sacrificing the diversity of cropland habitat and surround biodiversity (O'Connor & Shrub 1986; Altieri & Nicholls, 2018; Mickleburgh et al., 2002; Mickleburgh et al., 2009).

The evaluation results on the planting land in Sidorejo area, Kalasan Subdistrict, Yogyakarta in case of SETS model with IASMUSPEC of solar energy has a positive impact on increasing new student literacy and rice productivity. This is inseparable from intensive research in Laboratory of Acoustic Physics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta. The role of natural animal sounds has been proven to increase plant productivity. This is also relevant to the previous studies which explain that the number of insects in the area of agricultural land, in general, can increase yields (Tscharntke et al., 2012; Bartomeus et al., 2014; Verboom & Spoelstra 1999).

CONCLUSION

The application of the SETS (Science, Technology, Society, and Environment) approach through the Biophysics course has been proved as the right solution to develop new literacy (human literacy, digital technology literacy, and data literacy) among students in Natural Science Study Program, Faculty of Mathematics and Natural Science, Universitas Negeri Yogyakarta. The application of this approach can solve the students' learning difficulties in connecting SETS elements within learning by providing integrated technology that is in accordance with basic competencies and learning indicators. The relational model of Integrated Audio Stimulator - Multi-Sensor - Pest Control (IASMUSPEC) engineering to optimize the growth and productivity of organic food plants directly involves students in realistic science learning by applying technology to assist farmers. The preliminary study of this DRPM scheme results in two aspects. They are the skills improvement aspect for both students and farmers in applying IASMUSPEC, and the increase of productivity aspect in organic rice plants into 209.81% (yield total for land samples of 8.3 x 29.8 meters in the treatment plants was 237.3 kg, while for control plants was 113.1 kg). The effects of IASMUSPEC on plant growth rates were also examined. The analysis results showed a significant difference between the plants in the experimental and control field. The number of clumps in the sample area in the treated plants amounted to 1921, while in the control plant land was 1786. The intensity level of Garengpung sound measured with sound level meter was in the interval of 62.1 – 79.4 dB.

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