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The Development of Physics LMS Based on Science Literacy Related Energy Content in Agricultural Context (Farmer)

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Abstract: Farmer is a Physics learning media that functions as Learning Management System (LMS) to organize, manage, and deliver subject matter on the concept of energy and its changes related to work, changes in mechanical, chemical, electrical, heat and renewable energy on the basic techniques of plant production processes which refer to a science literacy-based learning flow with a web format for the vocational school of Agriculture. The purpose of this study was to analyze the concept of Energy and its changes in Agriculture that are used in the LMS Farmer. The Material of Energy and its changes in Agriculture in LMS farmers were developed using the ADDIE model 1) Analysis Phase; 2) Design Phase; 3) Developed Phase; 4) Implementation Phase; 5) Evaluation Phase. This research used the qualitative method. The non-test research instruments included material validations by four material experts consisting of two physics experts, one teacher and one Agricultural material expert. The data analysis techniques included descriptive statistics. The results showed that the material of Energy and its changes in Agriculture on LMS Farmer, based on the assessment by four experts lies in the "feasible" category. The conclusion of this study is that the material of Energy and its changes LMS Farmer in the feasible category so that they are feasible to be applied in physics learning for vocational schools majoring in Agriculture.

Keywords: Agriculture; LMS; Physics; Science literacy

Introduction

Currently, there are around 100 million Indonesians working in agriculture. The Vocational School Center for Excellence program for agricultural vocational schools is expected to shape students so that they have the skills to meet the requirements of the agricultural world of work through the ability to solve problems by a series of scientific evidence. Scientific literacy is a skill that includes problem-solving, decision proof, and logical evaluation of information (Glaze, 2018). Scientific literacy is also an ability of students as citizens reflective to engage in related issues and problems with science and its ideas (OECD, 2019). Acquisition of scientific skills in the 21st century, the age of digitalization is the foundation of understanding to help students adapt quickly to scientific advances, accelerate future technology and make a decision (Maulina, 2020).

Physics is essentially a science that studies phenomena through a series of processes known as scientific processes, built on scientific attitudes and results embodied as scientific products, and three main components consisting of universally applicable concepts, principles, and theories. Physics is a mathematical description of natural phenomena and the prediction of that natural phenomenon which is inferred from the results of measurements and observations (Holbrow et al., 2010).

Agriculture is actually a technique that optimizes the flow and concentration of energy as much as possible. Therefore, plants should be considered traps for extracting, converting, and storing energy. For this reason, efforts are needed to improve and increase the efficiency of energy use to achieve maximum results. The practice of the energy concept and its change in agriculture covers various basic techniques of plant products such as the process of plant breeding, land

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cultivation, planting, plant maintenance, harvesting and post-harvest handling, packaging, and distribution of harvested products. Knowledge of physical phenomena in the agricultural environment enables more efficient use of water and chemicals in agriculture and reduces biomass loss during harvesting, transportation, storage, and processing (Glinski et al., 2011).

Agrophysics is the study of the physical processes and properties that affects crop production. The basics of agrophysical investigations are the transport of mass (water, air, nutrients) and energy (light, heat) in the continuum of soil, plants, atmosphere and soil, machinery, agricultural products, food, and their arrangement to obtain biomass, as well as in quantity and quality with high ecological sustainability. Agrophysical processes and properties refer to the processes and properties used in agrophysics and are relevant to agrophysical objects, namely soils, plants, agricultural products, and food, with particular reference to agricultural and ecological applications (Glinski et al., 2011).

Energy is a quantity whose values can be calculated in different situations. The total energy of a system is conserved and this preservation allows us to make revealing calculations. Students should learn about energy because energy is basically a tool to do calculations that return values. These values enable accurate predictions and informed decisions (Tracy, 2021).

Energy and its changes are relevant physics concepts, related to process competence, and are widely used in the basic techniques of plant production processes. Energy and its changes relate to anything that can make an object do work. Energy forms and their changes include changes in mechanical, chemical, electrical, thermal energy, and renewable energy in the basic techniques of plant production processes. The concept of Energy and its changes in the curriculum of the vocational school center of excellence consists of three elements of scientific literacy, namely explaining phenomena scientifically, designing and evaluating scientific investigations, and translating data and scientific evidence in the context of Agriculture.

Lack of supporting facilities to achieve scientific literacy skills made the students have not mastered scientific literacy skills, so their ability of scientific literacy is still low (Budiarti et al., 2021). Farmer is a Physics learning media as learning management system (LMS) that functions to organize, manage, and deliver subject matter on the concept of energy and its changes related to work, changes in mechanical, chemical, electrical, heat, and renewable energy on the basic techniques of plant production processes in Agriculture which refers to a science literacy-based learning to flow with a web format. The purpose of this study was to analyze the concept of Energy and its changes in agriculture-related to the basic techniques of the plant production process used in the Farmer application developed by researchers using the validation of material experts in Physics and Agriculture that will be applied in learning Physics at a vocational high school majoring in Agriculture.

Method

This research is Research and Development (R&D), which aims to produce a product that is feasible and practical (Hasanah et al., 2020). Material development in learning management system (LMS) Farmer uses the ADDIE model 1) Analysis stage; 2) Design stage; 3) Developed Stage; 4) Implementation stage; 5) Evaluation Stage (Rayanto et al., 2020). The non-test research instruments included material validations by four material experts consisting of two physics experts, one teacher, and one agricultural material expert. Material experts provide perceptions regarding the quality of the content of Energy in Agriculture (basic techniques of plant production), the quality of presentation of the material, the quality of language, and the quality of learning. Each Expert needs a minimum of one week to analyze the quality of the Energy concept in the Farmer application. Several questions were asked to explore the quality of the concept of Energy and its changes to its implementation in the basic techniques of the plant production process related to the objectives to be achieved, the breadth and depth of the Energy material, and its changes in agriculture, the accuracy of concepts, data and facts, the accuracy of examples, cases, videos, animation, and simulation, as well as a sequence of concepts. The data analysis techniques included descriptive statistics.

Result and Discussion

The concept of Energy and its changes in LMS Farmer is structured using several stages: 1) Analysis phase includes policy and literacy analysis, agricultural context analysis, scientific literacy competency analysis, energy content analysis, and its changes, and learning objectives analysis; 2) Design phase includes grid and storyboard preparation, media selection, format selection, initial preparation; 3) Developed phase of the concept of energy and its changes in LMS Farmer uses the flow of science literacy learning; 4) Implementation phase consisted of validation by three validators who were experts in physics and one validator who was experts in agriculture, then the concept of energy and its

changes in agriculture is revised based on suggestions and corrections from experts.

Figure 1. The concept of energy and its changes in agriculture on LMS Farmer

Figure 1 shows the concept of Energy and its changes in agriculture on LMS Farmer. The concept of energy and its changes in agriculture developed following the flow of scientific literacy learning consist of explaining phenomena, conducting simulations or experiments and proving, and drawing conclusions. The practice of the energy concept and its change in agriculture covers various basic techniques of plant production including land cultivation, planting, plant maintenance, harvesting, and post-harvest handling.

The concept of work in land cultivation is seen when farmers plow the land in a modern way with tractors or traditionally using buffalo power. In plowing with a buffalo, the pulling force exerted by the buffalo on the plow that causes the plow to move is called work. This work occurs because the force exerted by the buffalo transfers energy to the plow. The drag force of the buffalo is not in the direction of the displacement (it forms an angle to the displacement). Without energy, the force cannot do work. Energy can be a measure of a body's ability to do work, In the simple case of a constant force pushing parallel to the line of motion of the object on which it acts, and pushing on it over some distance d, the work W done is defined as the amount of force F times the distance d over which the force acts (Holbrow et al., 2010). The form of energy involved in this event is kinetic energy. Kinetic energy is used to turn the soil into the cultivation of agricultural land. Kinetic energy is affected by the forward speed of the tractor and the mass of the plow used. This is in line with research that the method for increasing the working capacity of agricultural equipment, by increasing the speed of progress, it can increase the working capacity of land processing equipment without having to increase the weight and number of propulsion units that burden the soil. If the speed is greater, the work capacity will be even greater (Mardinata et al., 2014).

Before carrying out land processing, the selection of agricultural land locations should be safe from erosion and landslides. Under the influence of the earth's gravitational force, the soil will have stored energy. This energy is usually called Gravitational Potential Energy. The amount of potential for land to experience erosion and landslides is influenced by potential energy. The steeper an area, the potential energy of rainwater to transport soil materials will be greater, causing erosion. Potential energy can be used to predict which farmer will dig the deepest hole. Because the hoe is lifted to a certain height, the equation of potential energy applies when the farmer lifts the hoe to swing it to the ground. Where m is the mass of the hoe, g is the acceleration due to gravity, and h is the height the hoe is lifted from the ground before swinging. If the condition of the hoe mass is the same, and the acceleration due to gravity is the same, so the amount of potential energy is influenced by the height of the farmer lifting his hoe. The higher the farmer lifts the hoe, the greater the potential energy produced so that when the hoe is dropped to the ground it will sink deeper. This is in line with research that the amount of potential energy is influenced by the height of the farmer lifting his hoe (Arifi et al., 2021).

In the sowing phase, the seeds are planted in the soil by natural or drilled according to the recommended spacing for each plant. The seeds are inserted into the planting hole by letting them fall from above (the farmer's position is slightly tilted). When a seed falls into a planting hole, gravity causes it to fall freely. When the seed is at the highest position, the seed has potential energy at the maximum height position, and the object has no kinetic energy because the object's acceleration is zero. This happens because the object is not moving. After the seed falls and is at a certain height, the seed has potential energy and kinetic energy. The combination of potential and kinetic energy is called mechanical energy. After the object hits the ground, the object has no mechanical energy because the object's height is zero and the object's acceleration is zero. This is in line with the law of conservation of energy which states that energy is eternal, cannot be created, and cannot be destroyed, only changes form. This is as stated that energy in a closed system is conserved, and the total does not change (Holbrow et al., 2010).

In seed preparation, generally, food plant seeds are planted directly without seeding, but there are several types of plants that must be seeded before planting. The process of seed germination is influenced by several factors including seed dormancy. Dormancy is a state of seeds that have a period of rest and are difficult to germinate even in an environment that allows them to

grow. Seed germination depends on imbibition (absorb water). At the imbibition stage (absorb water), seeds absorb water from the surrounding environment. The imbibition of water causes the seeds to expand, breaking the seed coat and triggering metabolic changes in the embryo that cause the seeds to continue growing. One natural way that can be used to increase water access to the seeds, especially seeds that have a hard outer shell structure is to soak the seeds in hot water. In seed preparation, farmers use heat energy to help break plant dormancy. Heat energy is energy that moves from an object with a high temperature to an object with a low temperature. Heat energy in hot water can break dormancy. It helps the water imbibition process to accelerate seed germination. This is in line with research on breaking seed dormancy with hot water through an immersion treatment with a temperature of 80^0 C for 3 minutes which will cause the seed germination process to be faster which results in the length of the embryo's axis will also grow faster (Harahap et al., 2021).

Electrical energy is energy generated by electrically charged objects. In the maintenance of plants, electric energy is widely used by farmers to accelerate plant growth. This is in line with research that applying the right voltage can stimulate ions in the soil to reach activation energy, so that it is more quickly absorbed into plant roots, and can help plant growth (Al Indis, 2021). Chemical energy is chemically stored energy or the potential of a chemical substance to undergo a chemical reaction and then turn into another substance. The form of chemical energy can only occur in chemical energy storage devices such as fertilizers, herbicides, pesticides, fruit, leaves, soil, etc. Plant maintenance, harvest, and post-harvest use a lot of chemical energy. Plant maintenance activities use a lot of chemical energy including replanting, fertilizing, watering, hoarding, and controlling plant pest organisms (OPT) and pruning. If the chemical energy has been used by the plant until it reaches the physiological maturity level, it means the plant is ready to be harvested. Basically, chemical energy is needed in the plant maintenance process to optimize the nutrient content needed by plants to grow and develop. This is in accordance with research that state that nutrient absorption requires energy when plants absorb nutrients through roots (especially root hairs) or leaves and other parts (mainly through leaf stomata) where nutrients from soil solution are absorbed in the form of water, as well as through a process involving the exchange of ions from the surface of the root hair or root, the limited oxygen supply in the roots reduces the energy needed for metabolism, thereby reducing nutrient absorption (Handayanto et al., 2017).

Energy sources consist of renewable energy and non-renewable energy. Renewable energy sources are energy sources that can be replaced by natural processes so that they can continue to be sustainable. Water energy or also called hydropower is a source of energy generated from the power of water, water energy can be utilized and converted into electricity and hydroelectric power. Micro-hydro can be a solution for farmers in areas with heavy water flow to be used in irrigation and generate electricity that is useful for helping farmers in basic plant production techniques including irrigation, plant maintenance, harvest, and post-harvest. This is in line with research that states that the manufacture of micro-hydropower plants supports independent and sustainable agricultural development programs for farmer groups through the provision of cheap and environmentally friendly electrical energy supplies which has an impact on increasing income through decreasing production costs, increasing quantity, quality and competitiveness of horticultural cultivation production (Paryono et al., 2022).

Wind energy is energy produced by wind gusts that are processed and collected into large energy using windmills. Wind energy can be converted into mechanical energy to generate work used to grind rice, pump water, chop wood, and produce other forms of mechanical energy. This is in line with the research that with an average wind speed of 5.52 m/s, it can produce an output voltage of 78.47 volts AC whereas the generator will produce a minimum output voltage of 2.5 m/s wind speed (Nawawi et al., 2017). Solar energy is needed for the process of photosynthesis in plants to grow optimally with the main product being carbohydrates (sugar). Respiration is an activity of plants to obtain energy (ATP) through the breakdown of photosynthesis.

Solar energy is used as a solar power plant (solar cells) which can be used to turn on water pumps for irrigation. The maximum intensity of sunlight is produced during the day, and the greater the intensity of sunlight, the greater the value of the voltage and current. This is in line with research that solar power generation systems really help farmers to irrigate their agricultural land at a lower cost and are also environmentally friendly (Qomaria et al., 2021). Biomass is organic material derived from plants and animals. Materials derived from plants will later be burned so that they can produce biofuels or also known as BBN. Meanwhile, the fuel produced from animal and human waste gas is called biogas energy. Is as stated that waste biomass can be obtained from most components of agricultural and plantation waste streams that can be divided into lignocellulosic (eg, corn stover) or green biomass (eg, shrubs) and other grasses and herbaceous plants) (De Buck et al., 2020).

The material in Farmer's LMS is designed contextually by connecting accurate concepts, data, facts, and case examples to the content of Energy and Changes in Agriculture, namely the basic techniques of plant production as one of the skills students learn every day. This is in accordance with Rusman (2013) which states that a contextual approach can help students to see the meaning of the material by connecting the content of the material and events or phenomena in life, culture and individuals. Contextual learning materials are easily accessible and recognizable by students so learning science contextually provides meaningful learning for students (Taconis et al., 2016). Farmer's LMS material is contextualized with the field of Agriculture oriented towards Energy content and its changes and contains data, facts and case examples that are accurate in the basic techniques of plant production. The material is also arranged systematically based on scientific literacy covering aspects of content, context, competence and attitudes. This is as concluded that good science material is developed based on certain competencies to be achieved (Devetak et al., 2013), green biomass (eg, shrubs) and other grasses and herbaceous plants (De Buck et al., 2020). Teaching material that development based on scientific literacy generally emphasizes students' ability to use scientific knowledge in real-world situations (Ke et al., 2021).

Table 1. The Concept of Energy and its Changes in Agriculture on Farmer's LMS

Physics	Agriculture	Method to Evaluate
Work	Tillage with plows, hoes, and tractors	W = F.s
Kinetic energy	Land cultivation	K= ½.m.v²
Potensial Energy	Area selection and tillage with a hoe	U = mgh
Mechanical Energy	Seed planting process	Em= Ep + Ek
Heat Energy	Breaking seed dormancy	Q = m.c.at
Electrical Energy	accelerate plant growth	W =V.i t
Chemical Energy	Plant maintenance process	look up reaction
Renewable Energy	Utilization of water, wind, solar and biomass energy for agriculture	

Table 2. Aspects of Scientific Literacy

Content	Context	Competency	Attitude
Work	Land cultivation	Explain phenomena, Designing an investigation, Translate data	Care about land processing problems
Potensial Energy	Land cultivation	Explain phenomena, Designing an investigation, Translate data	Care about land processing problems
Kinetic energy	Land cultivation	Explain phenomena, Designing an investigation, Translate data	Care about land processing problems
Heat Energy	Planting preparation	Explain phenomena, Designing an investigation, Translate data	Care about the problem of planting preparation
Electrical Energy	Plant maintenance	Explain phenomena, Designing an investigation, Translate data	Care about the problems of plant maintenance
Chemical Energy	Plant maintenance, harvest and post-harvest	Explain phenomena, Designing an investigation, Translate data	Care about the problems of plant maintenance, harvest and post-harvest
energy change Renewable Energy	Basic techniques of crop production	Explain phenomena, Designing an investigation, Translate data	Cares about the basic technical issues of crop production

Scientific literacy is divided into four aspects consisting of aspects context, content (knowledge), competency (process) and attitude (OECD, 2018). The Energy material and its changes in Farmer's LMS are presented in a coherent and interrelated and student-centered manner where each section and sub-section of the material is designed as a learning resource so that students actively ask, question, and express their ideas. Material is presented to encourage active participation through scientific literacy competency activities to be achieved including explaining phenomena, designing and evaluating scientific investigations, and translating data and evidence scientifically. The Energy and Change material presented in the scientific literacy activity sections allows students to participate actively. In addition, the material on Energy and its changes in LMS Farmer uses language and text that can be read clearly and easily understood to achieve scientific literacy competence. Literacy Science must be built from the beginning of school because of this ability make students have an understanding of scientific concepts and knowledge, also a scientific process so as to enable students to take something decision with that knowledge (Nurkaenah et al., 2018).

Validation is a stage in development research that is carried out before product trials in the field.

Validation aims to produce teaching devices that have criteria worth using (Gultom, 2014). After the materials have been developed, the material characteristics of the LMS Farmer products that have been produced are then tested by material characteristics experts. Material validation is carried out through an expert test which aims to find out deficiencies or weaknesses in the material through input suggestions and corrections from expert validators so as to produce decent material.

The Farmer LMS material validation sheet consists of 30 questions. The validation of the material characteristics of Farmer's LMS was carried out by two lecturers from the Department of Physics Education, one lecturer in agriculture, and one Physics teacher at the Agricultural Vocational School. There are several suggestions and comments on the material that must be corrected, including the formulation of a mathematical effort using adding dots (writing dot (.) in the middle); on the locking force table investigation, with the phenomenon seems to be out of touch; motion accuracy may be better with video instead of moving images. Once validated, the Farmer LMS material is then revised according to expert advice.

The results of the validation of the material characteristics of LMS Farmer from 2 expert lecturers, 1 agriculture widyaiswara, and 1 Physics teacher at the Agricultural Vocational School obtained an average proportion of each aspect covering aspects of content 76.95% including the appropriate category, presentation aspects 79.18% including the feasible category, aspects scientific literacy 78.75% is included in the feasible category, the language aspect, namely 80.2%, is included in the feasible category.

Based on the validation of the Farmer's LMS material, in general it can be interpreted that the Farmer's LMS material is feasible and meets the specified characteristics, namely oriented towards Energy and Change content and contextual according to the field of Agriculture; contains accurate data, facts and case examples related to the content of Energy and Changes in the basic techniques of plant production; Arranged systematically based on scientific literacy covering aspects of content, context, competence, and attitudes; participatory and student-centered in Agricultural Vocational Schools.

Conclusion

LMS Farmer has special characteristics in terms of material aspects including: a) oriented to Energy content and its Changes and is contextual according to the field of Agriculture, b) contains accurate data, facts and case examples related to Energy content and Changes in basic plant production techniques, c) systematically arranged based on scientific literacy covering aspects of content, context, competence, and attitudes, d) participatory and student-centered at Agricultural Vocational Schools. Based on expert validation, the material characteristics in Farmer's LMS are feasible for used by Agricultural Vocational High School students.

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Author Contributions
Conceptualization, Herawati; methodology, Herawati; software, Herawati; validation, Herawati, A Setiawan and A Hidayat; formal analysis, Herawati; investigation, Herawati; resources, Herawati; data curation, Herawati; writing—original draft preparation, Herawati.; writing—review and editing, Herawati; visualization, Herawati; supervision, A Setiawan, A Hidayat; project administration, Herawati; funding acquisition, Indonesia Endowment Fund for Education (LPDP).

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Conflicts of Interest
The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, interpretation of data; in the writing of the manuscript; and in the decision to publish the results.

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