Ai Tusi Fatimah

Paving the way for integrated STEAM-H education in agricultural product processing vocational high school

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ADGVI ASOSIASI DOSEN & GURU VOKASI INDONESIA BEKERJA SAMA DENGAN PROGRAM PASCASARJANA UNY

Paving the way for integrated STEAM-H education in agricultural product processing vocational high school

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ABSTRACT

The increasing boundaries of agriculture and health disciplines in STEM to STEAM-H (Science, Technology, Engineering, Agriculture, Mathematics, and Health) is an opportunity for the world of education to expand integration between disciplines for solving increasingly challenging and complex problems. The Agricultural Product Processing Program, one of the spectrums of vocational education in Indonesia that focuses on agriculture, is located in the STEAM-H area. Therefore, this study aims to explore cross-subject connections, essential concepts, and teacher beliefs to implement integrated learning. This study used a qualitative approach with a case study design. Data were collected through interviews and documents. Participants were teachers at SMK Agrotechnology Processing Agricultural Products in Ciamis, Indonesia. Descriptive analysis was carried out on the standard subject matter of agribusiness, mathematics, and science to obtain an overview of interdisciplinary connections in STEAM-H and the essential concepts within it. The findings of this study are that mathematics and science have a role in processing agricultural products subject, as indicated by the existence of conceptual connections in them. Concepts of processing products of agriculture become conceptual and contextual integrators of science and mathematics. The essential concepts of mathematics and science are either explicit or implicit, within or outside the secondary school curriculum set by the government. Based on the participants' beliefs, integrated STEAM-H in learning can be carried out at agribusiness vocational schools. This finding has implications for integrated STEAM-H learning planning that requires further research.

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INTRODUCTION

Toni (2014) introduced STEAM-H (Science, Technology, Engineering, Agriculture, Mathematics, and Health) as an extension of the boundaries of multidisciplinary research. Agriculture and health are additional disciplines of STEM that have been popular. STEM education has been widely researched and developed beyond STEM disciplines with various objectives. Khine and Areepattamannil (2019) have integrated arts in STEM into STEAM as an effort to help students

understand analytical concepts through the use of creativity. Vallera and Bodzin (2020) have integrated agriculture through the STEM program with AgLIT (Agricultural Literacy Through Innovative Technology) to increase agricultural and STEM literacy. Denner (2020) has integrated health in STEM to find creative solutions to dealing with the Covid-19 problem.

Perceptions of STEM education experience many interpretations. Li (2014) views STEM education as subject-based education or as integrated STEM education. The discipline-based STEM approach defines the concepts and skills in each discipline separately. Gao et al. (2020) view STEM based on the nature of scientific disciplines, so three categories of STEM integration are monodisciplinary, interdisciplinary, and transdisciplinary. English (2016) views STEM based on its increased integration, so four classifications of STEM education are disciplinary, multidisciplinary, interdisciplinary, and transdisciplinary approaches.

The pattern of interdisciplinary integration has developed a lot. English (2016) explained that this pattern emphasizes the features of integration between two or more interconnected disciplines that study concepts and skills. Furthermore, Gao et al. (2020) explain that interdisciplinary is an effort to build relationships (knowledge and skills) between various disciplines to solve complex and sophisticated problems. Roehrig et al. (2021) explained that before implementing an interdisciplinary approach, we need to look at the nature of disciplinary integration to synchronize cultural differences between disciplines (differences in terminology, notation, and sign conventions).

Implementation of an interdisciplinary approach refers to the diversity of situations and goals. Barrett et al. (2014) integrated meteorological and engineering material presented in a module for junior and early secondary school students to increase learning achievement. Ku et al. (2022) tested high school students' STEM integration behavior at a national technology competition. Wang et al. (2020) explained that implementing an interdisciplinary approach requires confidence and preparation from teachers and their teams to set learning objectives and collaboration structures. Teachers also need to know the impact of STEM implementation on their institutions (Evans et al., 2019). However, the results of the study report that the implementation of integrated STEM has several challenges (pedagogical, curriculum, structural, and assessment), there are concerns about student and teacher support (Margot & Kettler, 2019), and a lack of confidence in implementation (Shernoff et al., 2017).

Based on the development of integrated STEM, integrated STEAM-H education can be an opportunity to be implemented for vocational schools engaged in agriculture. In Indonesia, vocational high schools in agriculture are agribusiness and agrotechnology with expertise programs consisting of crops, livestock, fisheries, processing of agricultural products, integrated agricultural businesses, and forestry (Minister of Education Culture Research and Technology of the Republic of Indonesia, 2022a). Each program has a more specific concentration. This research focuses on processing agricultural products.

By referring to the integrated STEM framework that has been developed by Kelley and Knowles (2016), English (2016), Gale et al. (2020), and Roehrig et al. (2021), integrated STEAM-H may become a new trend of multidisciplinary research in the world of education that supports elements of life. As an initial step in the development of integrated STEAM-H education, this research explored the connections of each subject involving the STEAM-H discipline, the important concepts of the curriculum, the nature of STEAM-H integration, and the beliefs of teachers to integrate several subjects and themes the integrator. The results of this study contribute to addressing barriers regarding pedagogical aspects, quality curricula, implementation effectiveness, and student, teacher, and teacher support in integrated learning (Margot & Kettler, 2019), which still require solutions..

RESEARCH METHOD

Paving the way to integrate STEAM-H in this study used a qualitative approach with a case study design. The research involved teachers at the agricultural product processing vocational high school in Ciamis District, Indonesia. Two schools organize this program. Participants are teachers in agriculture, mathematics, and science (physics, chemistry, biology). The agricultural discipline

teachers are teachers who teach according to the program or concentration of expertise and are better known as productive teachers. Table 1 shows the characteristics of the participants.

Table 1. Characteristics of Participants

Participants	Teaching Specification	Gender	Age (Year)	Length of Teaching (Years)	Ever used teaching STEM?
P1	Vegetable product processing	Female	27	1	Yes
P2	Basic techniques for handling agricultural products	Female	37	1	Yes
P3	Processing of animal products	Female	52	12	Yes
P4	Plantation processing	Female	26	4	No
P5	Processing of animal products	Female	61	4	No
P6	Basic quality control of agricultural products	Female	25	1	No
M1	Mathematics	Female	29	6	No
M2	Mathematics	Female	48	20	Yes
M3	Mathematics	Female	30	1	No
F1	Physics	Male	33	1	No
F2	Physics	Female	30	5	No
C1	Chemical	Male	33	7	No
C2	Chemical	Female	30	5	No
B1	Biology	Male	56	34	Yes
B2	Biology	Female	30	5	No

Participants received open-ended questions about the connection between the materials/concepts of agribusiness, mathematics, and science subjects (physics, chemistry, and biology). The concept comes from the content standards of secondary school education currently in force in Indonesia (Minister of Education Culture Research and Technology of the Republic of Indonesia, 2022b). Participants analyze the connections concepts by identifying the roles of mathematics, physics, chemistry, and biology in the standard content of agribusiness subjects. Extracting these connections aims to make STEAM-H connections more explicit and meaningful across disciplines and classes. The results of the analysis are then used to develop an understanding of the interaction between integrated content, skills, and ways of thinking (English, 2016), as well as to explore the important components of the curriculum (Gale et al., 2020), the central concept in each subject, as well as the nature of STEAM-H integration (Roehrig et al., 2021). Themes are core terms from curriculum content standards. Table 2 describes the themes of the core terms of the curriculum content standards.

Table 2. Integrator Theme

Theme	Code	Material scope
Health, work safety, and environmental conservation	HSE	Concepts, principles and procedures for occupational health and safety, first aid in accidents, personal protective equipment, environmental conservation
Business processes	Business	Industry classification, business scope, product planning, production process, marketing, equipment repair and maintenance as well as human resource management, logistics, job profile
Basic cultivation or production techniques	Production	Size reduction (cutting, slicing, grating, chopping, crushing, and grinding), thermal processes (cooling, freezing, pasteurization, sterilization, drying, roasting, roasting, and frying), chemical and biochemical processes (salting, sugaring, acidification/fermentation)), and separation processes (sifting, filtering, distillation, extraction, precipitation, agglomeration and evaporation)
The use of technology	Technology	Tools, product development and global issues
Entrepreneurship development	Entrepreneurship	Identification of business ideas/types, calculation and risk taking in developing and managing businesses, business management by utilizing knowledge and skills in the field of plant agribusiness expertise
Waste management	Waste	Handling solid waste, liquid waste, and hazardous and toxic waste

The scope in Table 2 is the conceptual basis for processing agricultural products in the curriculum. These concepts become interdisciplinary integrators in STEAM-H. To find out the connection between mathematics and science, the question: "What is the role of each math and science lesson on the basic concepts of agribusiness?". Figure 1 describes the flow of data analysis. The results of data analysis are the essential concepts of mathematics and science in each theme, both implicit and explicit.

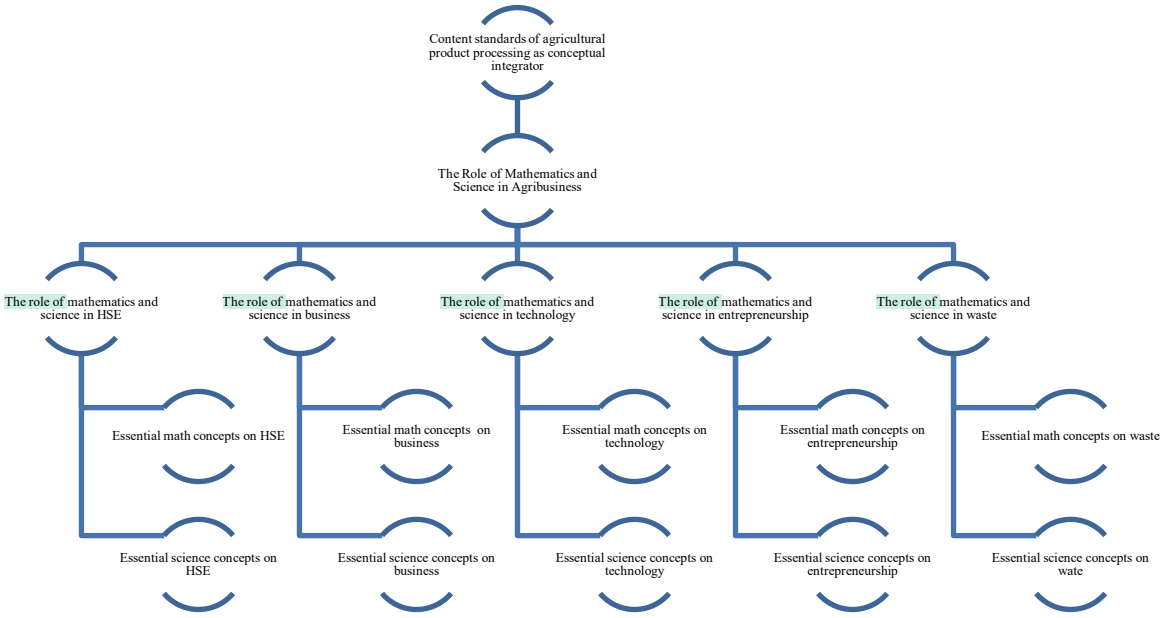

Figure 1. Data Analysis Flow

This study also explores participants' perceptions of beliefs about learning integration from several subjects and topics presented to students as conceptual integrators. The implementation belief of integrated learning is essential to challenges of intrinsic instructional (Dong et al., 2020) and determines teaching preparation (Wang et al., 2020). The chosen theme will be an integrator of two or more subjects to support student learning (Kelley and Knowles, 2016). Table 3 presents the questions posed to the participants.

Table 3. Distribution of Questions About STEAM-H Implementation Beliefs and Integrator Themes

Aspect	Question
Belief of integration implementation	Based on your perception, can agricultural product processing, mathematics, and science subjects be integrated together in intracurricular learning? If yes, how is the technical implementation? Are there any special prerequisites or conditions for implementation? If not, explain the reasons/technical constraints.
Integrator theme for math subjects	Based on your perception, what agricultural product processing contexts can be used as material in Mathematics Subjects?
Integrator theme for science subjects	Based on your perception, what agricultural product processing contexts can be used as projects/materials in science subjects?

FINDINGS AND DISCUSSION

Findings

The initial description as a result of the research is about the role of mathematical and scientific concepts (physics, chemistry, biology) on the content standards of agricultural product processing. Figure 2 illustrates the percentage of the role of mathematics and science (physics, chemistry, biology) in processing agricultural products in each integrator theme based on the responses of all participants. If explored further, the teachers argue that the concepts of mathematics and science have a role in each topic with different portions.

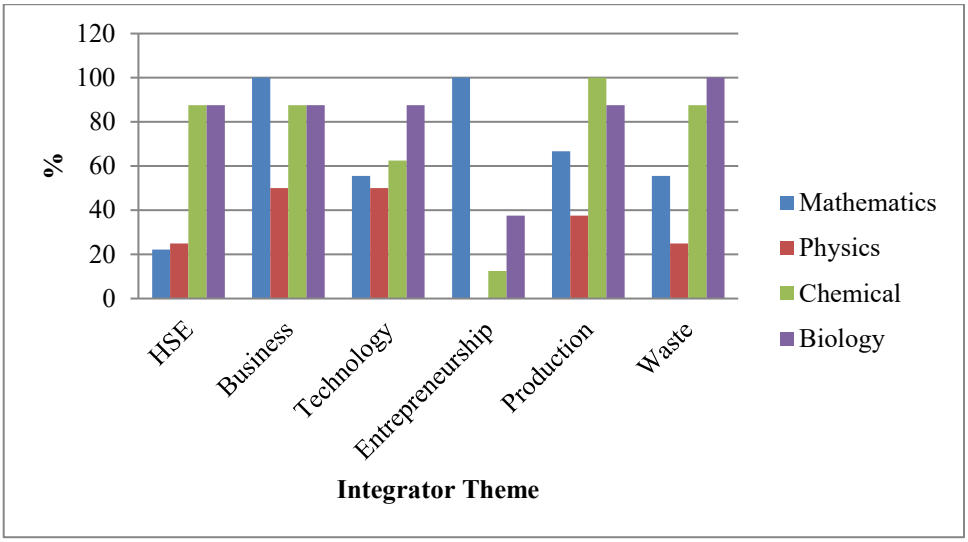

Figure 2. Percentage of Participants' Responses on the Role of Mathematics, Physics, Chemistry, and Biology on Content Standards for Agricultural Product Processing Subjects

In the HSE theme, chemistry and biology dominate the processing of agricultural products compared to mathematics and physics. Regarding business and entrepreneurship, mathematics has more roles than science. Regarding technology and waste management, biology is seen as having more of a role in processing agricultural products compared to mathematics, chemistry, and physics. On the production theme, chemistry has an important role in the processing of agricultural products. The participants perceive the mathematical and scientific concepts required for processing agricultural products explicitly or implicitly. Table 4 summarizes the important concepts of mathematics and science based on the participants' perspectives on the HSE theme.

Table 4. Participants' Perceptions of Mathematics and Science Concepts on the Themes of Health, Occupational Safety, and the Environment

Mathematics		Physics		Chemistry		Biology	
Productive teacher	Math teacher	Productive teacher	Physics teacher	Productive teacher	Chemistry teacher	Productive teacher	Biology teacher
Calculate the need for tools and materials to support occupation-al health and safety	Number operations, situation modeling, systems of linear equations, linear program-ming	-	Standard use of personal protective equipment and occupation-al health and safety procedures	Knowledge of chemical properties of materials for work safety	properties and characteristics of chemical substances; Maintenance of production equipment that requires chemicals	Environmen-tal conserva-tion to maintain the ecosystem; positive attitude towards the environment	Environ-mental ecosys-tem

Based on Table 4, the essential concepts of mathematics and science exist inside and outside the secondary school curriculum. Based on participants' perceptions, mathematics plays a role in determining the number of tools and materials for work safety, and science plays a role in workplace safety and the environment. Mathematics and physics concepts tend to be implicit in the HSE theme, while chemistry and biology tend to be explicit in the curriculum.

Furthermore, the theme of business processes covers the concept of industrial classification, business scope, product planning, production processes, marketing, equipment repair, maintenance, human resource management, logistics, and job profiles. Table 5 summarizes the participants' opinions on the role of mathematics and science in the business process theme.

Table 5. Participants' Perceptions of Mathematics and Science Concepts on the Theme of Agricultural Business Process

Mathematics		Physics		Chemistry		Biology	
Productive teacher	Math teacher	Productive teacher	Physics teacher	Productive teacher	Chemistry teacher	Productive teacher	Biology teacher
Analysis of opportunities in planning and production results; marketing, and profit	Real numbers, linear programming	Fluid and electrical concepts in the process of repair, maintenance, operation of equipment	In repair and maintenance there are physics concepts that need to be learned	Food safety in the production process (eg adding food additives to products); chemical substances in the product	Substance composition	Classification of living things with their environment; biotechnology such as fermentation techniques	Handling viruses and bacteria during packaging

Based on Table 5, we obtain explicit mathematical and scientific essential concepts that integrate disciplines. Mathematics is real numbers and systems of equations that occur more in the context of product planning, production processes, and marketing. Real numbers and systems of equations in the context of product planning, production processes, and marketing. Chemistry is the composition of substances in the production process and equipment maintenance/repair. The essential concept of biology is biotechnology in the context of the production process.

Next, we discuss the theme of basic techniques of crop agribusiness, fisheries, and processing of agricultural products. This theme is part of the agribusiness business process in the production process area. The material is more technical and in-depth than the material on business processes. Table 6 summarizes the participants' perceptions of mathematical and scientific concepts on the theme of basic techniques of agricultural product processing.

Table 6. Participants' Perceptions of Mathematics and Science Concepts on the Theme of Basic Techniques for Agricultural Product Processing

Mathematics		Physics		Chemistry		Biology	
Productive teacher	Math teacher	Productive teacher	Physics teacher	Productive teacher	Chemistry teacher	Productive teacher	Biology teacher
Measurement in cutting and slicing	Real numbers, comparisons, mathematical modeling	Food preservation by heat energy, thermal processes such as pasteurization, sterilization, etc.	The principle of separation of mixtures is based on the particle size/quantity which is basically in the measurement material	chemical properties of the material, chemical processes, chemical preservation such as salting sugar	Mixed separation	Environment to maintain ecosystems, changes in tissue structure in size reduction, coagulation, fermentation	Environment

Based on Table 6, the essentials of mathematics consist of real numbers, comparisons, measurements, mathematical modeling, and dimensions. This mathematical concept is more varied than other themes. Measurements and dimensions concepts are outside the secondary school

curriculum. On the other hand, the essential concepts of physics include matter and energy. The basic laws of chemistry, separation substances, purification substances, and colligative properties of solutions. The environment is the concept of biology.

Table 7. Participants' Perceptions of Mathematics and Science Concepts on Technology Themes

Mathematics		Physics		Chemistry		Biology	
Productive teacher	Math teacher	Productive teacher	Physics teacher	Productive teacher	Chemistry teacher	Productive teacher	Biology teacher
Opportunity calculation, data collection, tool calibration	Data comparison, linear programming, real numbers, linear equations	Digital data processing; Electricity, waves	Laws of Physics, Fluids, Thermodynamics	food safety for product development agricultural product such as storage and preservation	Development of agricultural products with chemically addictive ingredients; standard analytical chemistry of foodstuffs	Product development pays attention to environmental interactions; Biotechnological innovations (e.g. fermentation)	Environment; biotechnology

Table 7 shows the role of technology in processing agricultural products. The concepts of mathematics and science on the technology theme are more explicitly connected, especially in the context of equipment and product development. Both are part of the business process, while product development is specifically related to the basic techniques of cultivation or production. Therefore, the essential concept between business and basic cultivation/production techniques has a wedge.

Table 8. Participants' Perceptions of Mathematics and Science Concepts on the Theme of Entrepreneurship Development

Mathematics		Physics		Chemistry		Biology	
Productive teacher	Math teacher	Productive teacher	Physics teacher	Productive teacher	Chemistry teacher	Productive teacher	Biology teacher
Calculation and risk taking; Farming analysis	real numbers, matrices, linear equations, linear programming	-	-	Entrepreneurship development on target market and product classification	-	Growth and development of living things	-

On the entrepreneurship theme, mathematics tends to dominate connections compared to science because there is a concept in the standard of entrepreneurship content, namely calculating needs and taking risks in developing and managing businesses. The theme of entrepreneurship and business processes intersects with aspects of product planning, production processes, and marketing.

Table 9. Participants' Perceptions of Math and Science Concepts on the Theme of Waste Management

Mathematics		Physics		Chemistry		Biology	
Productive teacher	Math teacher	Productive teacher	Physics teacher	Productive teacher	Chemistry teacher	Productive teacher	Biology teacher
Measurement of certain doses of chemicals in chemical waste handling	Matriks	-	Waste handling equipment (vacuum, aerator, etc.)	Chemical properties of waste	Separation and purification of substances, titration, colloids in sewage treatment	food safety; positive attitude towards the environment	Waste and pollution

Waste management is an integrator theme and interest because it can involve all STEAM-H concepts. In the aspect of science, it is seen in Table 9 that many have a role, especially in chemistry and biology. Based on Tables 4-9, we can see the role of mathematics and science in agribusiness content standards, which have many connections. This result aligns with the participant's beliefs about the possibility of implementing integrated STEAM-H-based learning in a 100% confident position to implement STEAM learning.

Table 10 describes the specific themes chosen by the participants of agricultural product processing-mathematical and agricultural product processing-science subjects in the STEAM-H learning. Participants argued about implementing STEAM-H learning integrated with agricultural projects through syllabus adjustments, models learning, and plans to learn, using a schedule, student grouping, a continuous cultural process from the beginning of planning to results, and adequate financial support.

Table 10. Participants' Perceptions of Integrator Topics for STEAM-H Implementation

"Specific" integrator theme	
Agribinis-Math	Agribisnis-Sains
Agricultural product processing business planning	Handling of production waste
Material composition measurement	Vegetable products and animal products
Organoleptic test	Product development and food diversity
Business analysis	

The topics in Table 10 are believed by the participants to be implemented with learning strategies that involve agricultural projects. Participants see the need for syllabus adjustments, learning models, integrated learning plans for all subjects, use of time schedules, student groupings, a continuous cultural process from initial planning to results, and adequate financial support. Another belief of the participants in the possibility of successful implementation of integrated STEAM-H in agricultural product processing agrotechnology is the establishment of communication between teachers of mathematics, science, and productive subjects.

Discussion

STEAM-H has six disciplines. Science, mathematics, and agriculture are explicit subjects at SMK processing agricultural products. Technology, engineering, and health are implicitly included in the standards for processing agricultural products. Science in vocational learning is carried out partially or integrated. The research results show that there is a connection between the six disciplines. Fatimah et al. (2022) stated that making an explicit STEAM-H connection is the first step in an integrated STEAM-H implementation. According to English (2016), connections between two or more disciplines can be established.

Mathematics and agriculture are two related disciplines. The results of this study indicate a connection between the two. The connection between mathematics and agriculture can be seen from the role of both, as Muhrman (2016) revealed that mathematics is used by farmers all the time. Fatimah and Solihah (2021) explained the role of mathematics in producing processed vegetable products, namely calculating and measuring the various needs for tools, materials, and business planning analysis for producing processed vegetable products. Furthermore, Fatimah (2021) examines mathematical connection skills by presenting math assignments in an agricultural context to students. The results show that many students can make connections between mathematics and agriculture even though students are less able to make connections between mathematical concepts. These results show mathematics and disciplines' connection to mathematical thinking (Kelley & Knowles, 2016).

The results of this study also show that there is a connection between science and agriculture. The results of this study are supported by the results of the identification of physics concepts in agribusiness subjects conducted by Toto et al. (2022), which states that agricultural technology requires physical concepts and principles (quantity, measurement, fluid statics, fluid dynamics, heat, temperature, electricity). Hidayat et al. (2010) revealed the dominance of science in agriculture over

the local knowledge of farmers to realize an increase in food production. The findings also show a connection between science, technology, and agriculture.

The integration of science and engineering in education has also been carried out, even though the integration of agricultural engineering has yet to emerge. Pleasants et al. (2021) state that the use of science in engineering design still needs to be deeper and only lies at the end of the unit. Conceptual connections that are built can utilize and adapt engineering curriculum materials. Brand (2020) states that the development of understanding and practical value of science and engineering is determined by the exploratory nature of projects and instructional outcomes with their students. The strategy that can be implemented to achieve interdisciplinary integration is to redesign the curriculum Newton et al. (2018) with a discipline-based design. This design requires an educational research community with a deep grounding in disciplinary priorities, worldviews, knowledge, and practice (Henderson et al., 2017). Vocational secondary schools can adopt a discipline-based design strategy centered on agriculture. Agriculture is a conceptual integrator for science, technology, engineering, mathematics, and health.

Integrators can be concepts or contexts that combine various disciplines (Roehrig et al., 2021). Science, technology, engineering, agriculture, mathematics, and health can each become conceptual and contextual integrators for other disciplines. Fatimah et al. (2022) state that determining the integrator is an important step in preparing to implement STEAM-H-based learning after determining learning outcomes. Selecting agricultural integrators for vocational school students majoring in agricultural product processing is the right step to support student skills. The themes in the agribusiness concept classified into HSE, business processes, use of technology, cultivation, entrepreneurship, and waste handling can be selected as conceptual integrator themes in applying science and mathematics.

Connection is important to realize curriculum coherence in integrated STEAM-H implementation in agricultural product processing vocational schools. Connections that are explicit and contained in the curriculum are the most important components, even though not all math and science concepts are connected to other disciplines in STEAM-H. Therefore, it is necessary to understand the nature of integration in the designed curriculum unit. Agricultural concepts (including technology, engineering, and health in agriculture) can be conceptual and contextual integrators of science and mathematics concepts seen explicitly or implicitly in the curriculum. In addition, an understanding of the important concepts at the grade level is required.

The teacher's belief in this study is capital in implementing integrated STEAM-H. This belief is in line with Dong et al. (2020), which states that even though prospective teachers do not have a strong understanding, they have strong beliefs and intentions to teach STEM in their future careers. The results of this study indicate that teachers of agricultural vocational high schools know interdisciplinary connections, are aware of essential concepts for students, and have their beliefs about the possibility of implementing STEAM-H-based learning.

CONCLUSION

Integrated STEAM-H-based learning is very promising to be implemented in agricultural processing vocational schools. The teacher's perspective on the role of mathematics and science in content standards for processing agricultural products shows a lot of conceptual connections between them. The concepts of processing agricultural products become conceptual and contextual integrators of science and mathematics concepts. The concept of mathematics and science has a role in each theme with different portions. Dominant chemistry and biology have a dominant role in the processing of agricultural products compared to mathematics and physics on the theme of health, work safety, and the environment. Mathematics has a dominant role compared to science on the theme of business and entrepreneurship. Biology is dominant in the technology and waste handling theme compared to mathematics, chemistry, and physics. Chemistry has an important role in the dominant production of processing agricultural products. The teacher's belief in implementing integrated STEAM-H is supported by the teacher's knowledge of interdisciplinary connections and the determination of specific integrator themes to integrate agriculture and mathematics as well as agriculture and science. The results of this study provide opportunities for further research to

understand the nature of integration in the STEAM-H curriculum unit, which produces a conceptual flow for each subject at the grade level. Variations in integrator themes that have been explained based on participants' perceptions as teachers in agricultural product processing vocational schools will pave the way for understanding the nature of this integration.

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REFERENCES

Barrett, B. S., Moran, A. L., & Woods, J. E. (2014). Meteorology meets engineering: An interdisciplinary STEM module for middle and early secondary school students. *International Journal of STEM Education*, *1*(1), 6. https://doi.org/10.1186/2196-7822-1-6

Brand, B. R. (2020). Integrating science and engineering practices: outcomes from a collaborative professional development. *International Journal of STEM Education*, *7*(1), 1–13. https://doi.org/10.1186/s40594-020-00210-x

Denner, J. (2020). *STEM education + health education = Creative solutions*. ETR. https://www.etr.org/blog/stem-education-health-education-creative-solutions/

Dong, Y., Wang, J., Yang, Y., & Kurup, P. M. (2020). Understanding intrinsic challenges to STEM instructional practices for Chinese teachers based on their beliefs and knowledge base. *International Journal of STEM Education*, *7*(1), 1–12. https://doi.org/10.1186/s40594-020-00245-0

English, L. D. (2016). STEM education K-12: Perspectives on integration. *International Journal of STEM Education*, *3*(1), 1–8. https://doi.org/10.1186/s40594-016-0036-1

Evans, P. K., Dillard, K. C., Rodriguez-Wilhelm, D., & McAlister-Shields, L. (2019). Like-minded people: University-based interdisciplinary collaborations in STEM teacher preparation programs. *Journal for STEM Education Research*, *2*(1), 35–54. https://doi.org/10.1007/s41979-019-00011-0

Fatimah, A. T. (2021). Koneksi matematis siswa pada tugas matematis berbasis hasil pertanian: Konteks, konsep, dan prosedur matematis. *Jurnal Elemen*, *7*(2), 295–309. https://doi.org/10.29408/jel.v7i2.3176

Fatimah, A. T., Isyanto, A. Y., & Toto, T. (2022). *Pengantar untuk konversi: Pendidikan STEM ke STEAM-H*. Perkumpulan Rumah Cemerlang Indonesia. http://repository.unigal.ac.id:8080/bitstream/handle/123456789/3117/all konversi STEM ke STEAM-H.pdf?sequence=1&isAllowed=y

Fatimah, A. T., & Solihah, S. (2021). Desain bahan ajar berbasis agribisnis pengolahan hasil pertanian. *Teorema: Teori Dan Riset Matematika*, *6*(1), 25–33. https://doi.org/10.25157/teorema.v6i1.4487

Gale, J., Alemdar, M., Lingle, J., & Newton, S. (2020). Exploring critical components of an integrated STEM curriculum: An application of the innovation implementation framework. *International Journal of STEM Education*, *7*(1), 1–17. https://doi.org/10.1186/s40594-020-0204-1

Gao, X., Li, P., Shen, J., & Sun, H. (2020). Reviewing assessment of student learning in interdisciplinary STEM education. *International Journal of STEM Education*, *7*(1), 1–14. https://doi.org/10.1186/s40594-020-00225-4

Henderson, C., Connolly, M., Dolan, E. L., Finkelstein, N., Franklin, S., Malcom, S., Rasmussen, C., Redd, K., & John, K. St. (2017). Towards the STEM DBER alliance: Why we need a discipline-based STEM education research community. *Journal of Engineering Education*, *106*(3), 349–355. https://doi.org/10.1002/jee.20168

Hidayat, T., Pandjaitan, N. K., & Dharmawan, A. H. (2010). Kontestasi sains dengan pengetahuan lokal petani dalam pengelolaan lahan rawa pasang surut. *Sodality: Jurnal Transdisiplin Sosiologi, Komunikasi, Dan Ekologi Manusia*, *4*(1), 1–16. https://journal.ipb.ac.id/index.php/sodality/article/view/5855

Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education*, *3*(1), 1–11. https://doi.org/10.1186/s40594-016-0046-z

Khine, M. S., & Areepattamannil, S. (2019). *STEAM Education*. Springer International Publishing. https://doi.org/10.1007/978-3-030-04003-1

Ku, C.-J., Hsu, Y.-S., Chang, M.-C., & Lin, K.-Y. (2022). A model for examining middle school students' STEM integration behavior in a national technology competition. *International Journal of STEM Education*, *9*(1), 1–13. https://doi.org/10.1186/s40594-021-00321-z

Li, Y. (2014). International Journal of STEM Education - A platform to promote STEM education and research worldwide. *International Journal of STEM Education*, *1*(1), 1–2. https://doi.org/10.1186/2196-7822-1-1

Margot, K. C., & Kettler, T. (2019). Teachers' perception of STEM integration and education: A systematic literature review. *International Journal of STEM Education*, *6*(1), 1–16. https://doi.org/10.1186/s40594-018-0151-2

Minister of Education Culture Research and Technology of the Republic of Indonesia. (2022a). *Keputusan Menteri Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia Nomor 56/M/2022 tentang Pedoman Penerapan Kurikulum dalam Rangka Pemulihan Pembelajaran*. Ministry of Education, Culture, Research and Technology of the Republic of Indonesia. https://jdih.kemdikbud.go.id/sjdih/siperpu/dokumen/salinan/salinan_20220215_093900_Salinan Kepmendikbudristek No.56 ttg Pedoman Penerapan Kurikulum.pdf

Minister of Education Culture Research and Technology of the Republic of Indonesia. (2022b). *Peraturan Menteri Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia Nomor 7 Tahun 2022 tentang Standar Isi pada Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, dan Jenjang Pendidikan Menengah*. Ministry of Education, Culture, Research and Technology of the Republic of Indonesia. https://jdih.kemdikbud.go.id/detail_peraturan?main=3021

Muhrman, K. (2016). *Mathematics in agriculture and vocational education for agricultures*. https://hal.science/hal-01287937/document

Newton, S., Alemdar, M., Hilton, E., Linsey, J., & Fu, K. (2018). Incorporating industrial design pedagogy into a mechanical engineering graphics course: A Discipline-Based Education Research (DBER) approach. *International Journal of STEM Education*, *5*(1), 1–14. https://doi.org/10.1186/s40594-018-0122-7

Pleasants, J., Tank, K. M., & Olson, J. K. (2021). Conceptual connections between science and engineering in elementary teachers' unit plans. *International Journal of STEM Education*, *8*(1), 1–17. https://doi.org/10.1186/s40594-021-00274-3

Roehrig, G. H., Dare, E. A., Ring-Whalen, E., & Wieselmann, J. R. (2021). Understanding coherence and integration in integrated STEM curriculum. *International Journal of STEM Education*, *8*(1), 1–21. https://doi.org/10.1186/s40594-020-00259-8

Shernoff, D. J., Sinha, S., Bressler, D. M., & Ginsburg, L. (2017). Assessing teacher education and professional development needs for the implementation of integrated approaches to STEM education. *International Journal of STEM Education*, *4*(1), 1–16. https://doi.org/10.1186/s40594-017-0068-1

Toni, B. (2014). *New Frontiers of Multidisciplinary Research in STEAM-H (Science, Technology, Engineering, Agriculture, Mathematics, and Health)* (Vol. 90). Springer International Publishing. https://doi.org/10.1007/978-3-319-07755-0

Toto, T., Fatimah, A. T., & Yuniawan, A. (2022). Identifikasi konsep-konsep fisika dalam pembelajaran berbasis STEAM-H di SMK Agribisnis. *Prosiding Seminar Nasional Fisika (SiNaFi) 8.0*, *1*(1), 20–30. http://proceedings2.upi.edu/index.php/sinafi/article/view/2976

Vallera, F. L., & Bodzin, A. M. (2020). Integrating STEM with AgLIT (Agricultural Literacy Through Innovative Technology): The efficacy of a project-based curriculum for upper-primary students. *International Journal of Science and Mathematics Education*, *18*(3), 419–439. https://doi.org/10.1007/s10763-019-09979-y

Wang, H.-H., Charoenmuang, M., Knobloch, N. A., & Tormoehlen, R. L. (2020). Defining interdisciplinary collaboration based on high school teachers' beliefs and practices of STEM integration using a complex designed system. *International Journal of STEM Education*, *7*(1), 1–17. https://doi.org/10.1186/s40594-019-0201-4