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Research Article

Students' perceptions of the vermicompost as a potential contextual learning resources

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Abstract: Biology learning must strengthen the character of students caring for the environment concerning general and domestic waste. Domestic waste in the form of fecal sludge is a contextual environmental problem that must be managed properly. Sludge still has a fairly high concentration of nutrient content that can be utilized. The purpose of this study was to determine students' perceptions of the benefits of vermicompost as a source of contextual biology learning. As many as 239 public and private junior high school students in Metro City participated in filling out the online questionnaire. The questionnaire was developed by referring to the environmental care character criteria from the student's perspective which includes five main indicators, namely concern for the environment, responsible attitude, student knowledge about vermicompost, student motivation for contextual learning, and commitment to developing vermicompost. Data were analyzed descriptively referring to the critical success factors (CSFs). The results of the research showed that there were 5 student perceptions regarding the character of caring for the environment, namely students gave a strongly agree perception of 38.31%, a agree perception of 41.06%, a somewhat agree perception of 18.19%, a disagree perception of 2 .04, and strongly disagree at 0.40%. Students' perceptions of their environmentally caring character are influenced by many factors, namely students' knowledge and understanding of human fecal sludge and its benefits, a sense of responsibility for environmental sustainability, and students' level of education. Those who understand environmental sustainability and the benefits of fecal sludge have the perception that fecal sludge can be utilized through vermicompost and this process can be utilized as a contextual learning resource.

Keywords: contextual learning resources; environmental care character; human excrement sludge; vermicompost

1. Introduction

Contextual learning is a learning approach that connects between the learning material with real life situations. This creates a more relevant and meaningful learning experience for students. This approach aims to increase students' understanding by relating the concepts learned in class to the situations and problems they face every day. Contextual learning requires contextual learning resources. Contextual learning resources can be found in students' surroundings. Contextual learning resources provide better learning meaning compared to textual ones. Contextual learning resources are a more dynamic and meaningful learning approach compared to textual learning resources. Learning resources with this approach can reduce the gap between theory and practice, increase the relevance of the subject matter, and facilitate ongoing understanding. By integrating contextual learning resources into the curriculum, educators can help students not only learn but also understand, apply, and appreciate the knowledge they gain for everyday purposes (Chang et al., 2020; Lebreton et al., 2019; Paristiowati et al., 2019; Sailer et al., 2021). One source of learning about waste and its handling is domestic waste in the form of human feces. Through contextual learning resources, it is hoped that learning will be more meaningful (Muhfahroyin & Lepiyanto, 2020; Muhfahroyin & Oka, 2021; Shinta & Ain, 2021; Surata, 2019). Human feces are one of the types of domestic waste that continues to increase. Environmental problems are one of the problems that is the responsibility of every citizen. Garbage, both organic and inorganic, as well as other waste such as domestic household waste (feces, urine) are

serious environmental problems to face (Puwanti, 2017). Environmental problems not only occur in households but also in schools. Therefore, schools are also one of the places that produce the waste mentioned above. The lack of concern among school residents regarding the management and use of waste in schools' results in waste piling up and only ending up in rubbish dumps. There are several types of waste, including organic waste that can be recycled, such as leaves, vegetables, fruit and food waste. Then there are types of inorganic waste that cannot be recycled, such as plastic, cans, rubber, bottles. Organic waste that can be recycled can be reused and can be used as a contextual learning resource (Muhfahroyin & Oka, 2021).

Fecal sludge is the result of human waste which will continue to increase in number along with population growth. If it is not managed properly, it can become an environmental problem because this waste is a burden with high organic levels and toxicity for the environment (Hoang, 2022). Fecal sludge management is intended as an effort to achieve one of the goals of spatial planning, namely creating a safe, comfortable, productive and sustainable national regional space (Hoang, 2022; Undang-undang No. 26, 2007). Sludge contains nutrients in a fairly high concentration compared to those contained in the wastewater. The material contained in fecal sludge is solid organic substances, fat/oil, sand (grit) and has the potential to be a place for the growth of various disease viruses, bacteria and parasites (Moningka et al., 2015). Without realizing it, increasing amounts of waste can cause pollution, the earth becomes damaged, increases emissions of CO_2, methane and other gases (Yaashikaa et al., 2022). Therefore, awareness in protecting the environment is very important (Lubis et al., 2020). Instilling awareness of protecting the environment can be done through education, it is hoped that it can become a means of socialization and understanding for students, teachers and school residents with the character of caring for the environment (Lubis et al., 2020; Fatmah, 2018; Surata, 2019). Through education, it is hoped that students can raise awareness of waste processing and concern for the environment in general. Awareness of managing waste using the 3 R method (reduce, reuse, recycle) has been widely socialized, however management of domestic waste in the form of feces has not been carried out much, so this waste will only accumulate in final disposal sites at fecal sludgee processing installations.

One of the efforts to increase the contextual character of caring for the environment is to provide students with an understanding of the problem of hazardous household waste and waste if not properly managed and processed. Contextual learning provides more meaningful learning (Paristiowati et al., 2019; Sailer et al., 2021; Skukauskaitė & Girdzijauskienė, 2021) Students are given an understanding that faecal waste can still be utilized to become compost, because feces still contain beneficial nutrients for plants. This requires processing (treatment). The processing results are expected to reduce pollution and the spread of disease if disposed of on the ground. One of the efforts to utilize fecal sludge is to make compost/humanure with the help of worms or vermicompost (Anggraeni et al., 2022; Mashur et al., 2001). To make fecal sludge as compost, a sludge drying process is required, bearing in mind that the water content in fecal sludge is also very high. Basically, the process of making humanure compost is carried out with a mixture of human feces, soil, and dry leaves as a mixed ingredient, which is an aerobic process (Fitriana et al., 2017). Dried leaves are an important mixed ingredient in the process of making compost. The availability of air and nutrients also greatly helps increase the efficiency of the manufacturing process. Adding a mixture of dry leaves in the composting process will more or less encourage a denser and more airy mixture. so that the process of making organic fertilizers is much more effective and efficient. After students understand the process of processing feces, students can do the processing themselves, both at home and at school, so that the character of caring for the environment will be formed more meaningful for students.

2. Materials and Methods

The research was conducted by using a quantitative approach with a survey design. In this educational research, a survey design was chosen because it is a quantitative procedure that seeks to collect and describe student thinking tendencies (Creswell, 2012). Data were collected using 10 closed-ended questions administered online (n=239, randomly selected). The sample is junior high school students grades 7-9 from 15 public and private schools in Metro City. The questionnaire was developed by referring to the criteria for environmentally caring character from a student's perspective (Naveed et al., 2020), covering five main indicators, namely concern for environmental sustainability, responsible attitude towards the environment, student knowledge about vermicompost, student motivation for contextual learning from vermicompost, and commitment to participate in developing human faeces vermicompost.

The questionnaire was then validated with a validity index (Aiken, 1985). The Aiken Validity Index (Aiken's V) was used to assess the content validity of the questionnaire developed by researchers. This validation is carried out by material experts and evaluation experts. Validation steps include 1) determining the goal and context, 2) selecting experts, 3) item assessment, 4) calculating the Aiken validity index, and 5) interpreting validation results. In validating this research instrument, the Aiken Validity Index (Aiken's V) was obtained at 0.83. The Aiken Validity Index (V) value ranges from 0 to 1. The index close to 1, its mean that the content validity of the item is better. This means that the validation results of the instruments used to collect data of the research were valid. The reliability test uses Cronbach's Alpha to assess the internal consistency of the questionnaire used in this research. The steps for reliability testing using Cronbach's Alpha include 1) data collection, 2) determining the items in the instrument, 3) calculating Cronbach's alpha (assisted by SPSS ver. 25), and 4) interpreting the results. Based on calculations, a Cronbach's Alpha value of 0.634 was obtained, greater than 0.05, which means the instrument used in this research is questionable. The collected data were analyzed using descriptive statistics to describe students' perceptions of environmental care characters. To obtain a complete, detailed and in-depth picture, the discussion is carried out thematically in the description of each aspect with reference to the critical success factors (CSFs) proposed by (Mosakhani & Jamporazmey, 2010).

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3. Results

The research was carried out covered five aspects of student perception, namely student's environment careness, responsible attitude towards the environment, student perceptions about vermicompost, student motivation in contextual learning of vermicompost, and commitment to participate in developing vermicompost. The following describes each aspect of student perception.

3.1 Students Environmental Careness

Carrying out of research on the perceptions of junior high school students in Metro City regarding their environmentally caring character. with various levels of agreement measured by a Likert scale, namely strongly agree, agree, moderately agree, disagree, and strongly disagree. Percentage distribution of student responses: 53.40% strongly agree, 36.45% agree, 8.95% quite agree, 1.00% disagree, 0.20% strongly disagree. Agree that in this case students have a good perception of environmental concern. The research results showed that the majority of students (53.40%) strongly agreed with the statement about the character of caring for the environment. This is a positive sign indicating that the majority of students have a strong perception about the importance of environmentally caring character. Apart from that, most of the other students (36.45%) also agreed with this statement. This shows that the majority of students generally have a supportive perception of the character of caring for the environment, although perhaps

not as strongly as those who strongly agree. The proportion of students who disagree (1.00%) and strongly disagree (0.20%) is very small. This shows that a small number of students have the opposite perception of the character of caring for the environment, but the number is very small. Visualization of the average perceived score of environmental care in students can be seen in Figure 1.

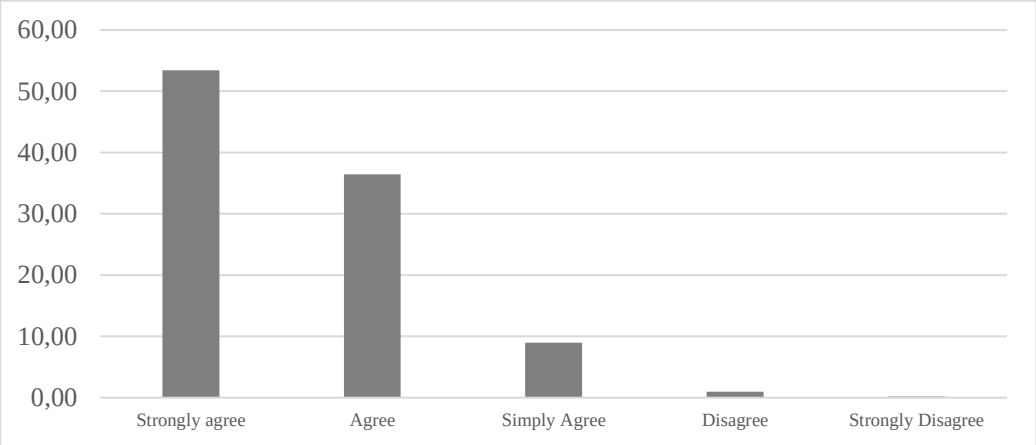

Figure 1. The average score of students' perception of concern for the student environment.

3.2 Student Perceptions of Responsibility

The research results show that the majority of students (82.90%) have a positive attitude towards responsibility for environmental issues, namely they strongly agree (40%) or agree (42.90%). This reflects a fairly high level of awareness among junior high school students in Metro City regarding their responsibility for environmental issues. Some other students (14.55%) stated that they quite agree, which could be considered a neutral attitude or perhaps having a lower level of responsibility compared to those who strongly agree or agree. The proportion of students who disagree (2.25%) and strongly disagree (0.30%) is very small. This shows that only a small proportion of students have a negative attitude towards environmental responsibility. In this context, social support theory can be linked. Social support can influence individual attitudes and actions towards environmental problems. Visualization of students' environmental awareness perceptions can be seen in Figure 2.

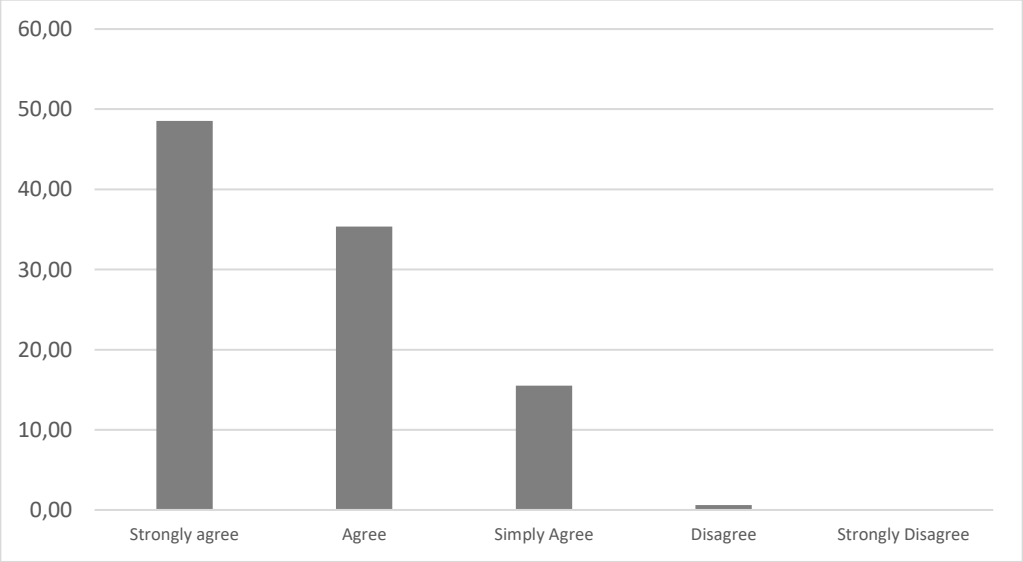

Figure 2. The average score of students' perception of responsibility for environmental issues.

3.3 Students' Perceptions of Vermicompost

The research results showed that the majority of students (48.55%) responded strongly agreeing with knowledge about vermicompost. In addition, 35.35% of students gave an agree response, while 15.50% of students gave a somewhat agree response. Only a small percentage of students said they disagreed, 0.60%, and none said they strongly disagreed. The results of this study indicate that the majority of students have good knowledge about vermicompost. Responses were strongly agree and agree indicating that they had obtained information about this method. This reflects efforts in environmental education to increase students' understanding of how to manage organic waste sustainably. A visualization of students' perceptions about vermicompost can be seen in Figure 3.

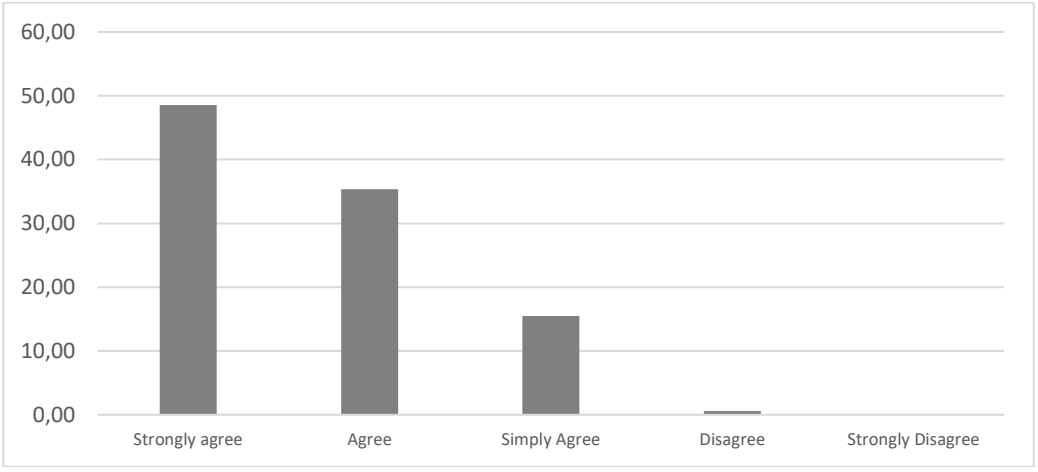

Figure 3. The average score of students' perceptions of knowledge about vermicompost.

3.4 Students' Motivation in Contextual Learning

The results of the research showed that the majority of students (69.75%) responded positively to contextual learning. More than half of the respondents (43.35%) agreed that they were motivated to participate in this contextual learning, while 26.40% felt they strongly agreed. This reflects that most students feel the relevance and meaningfulness of contextual learning. Even though the majority of students had a positive response, there was a small portion (25.35%) who quite agreed. This suggests there is variation in students' perceptions, and some of them may need further encouragement to be more motivated in contextual learning. The proportion of students who disagree (3.90%) and strongly disagree (1.00%) is very small. A visualization of students' perceptions of motivation to participate in contextual learning can be seen in Figure 4.

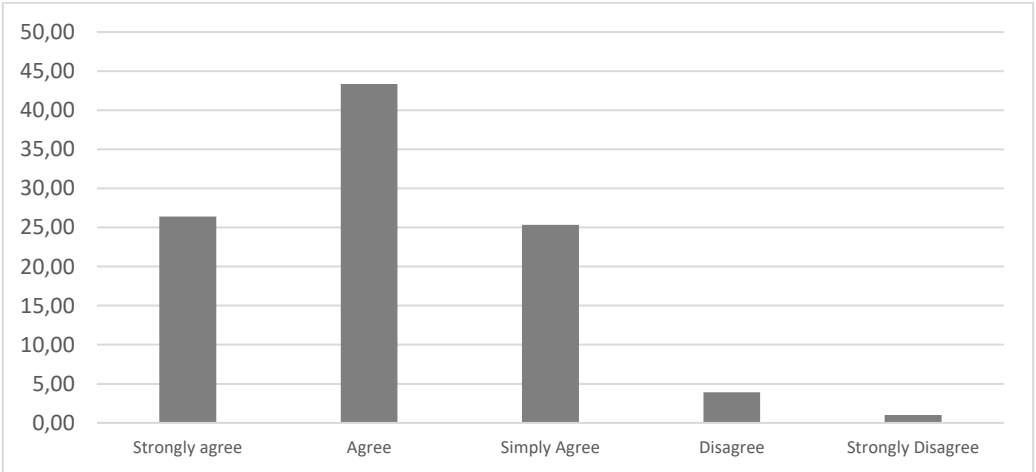

Figure 4. The average score of students' perceptions of contextual learning motivation.

3.5 Student Commitment to Developing Vermicompost

The results of the research showed that the majority of students (70.45%) had a positive response to the commitment to develop vermicompost. More than half of the respondents (47.25%) agreed that they were ready to be involved in the development of vermicompost in their schools, while 23.20% strongly agreed. This reflects students' awareness of the importance of organic waste management and sustainability. This high level of agreement indicates students' interest in the environment and their concern for environmental issues. They realized that vermicompost was a positive step in reducing organic waste and producing useful compost. Even though the majority of students have a positive commitment, there are still a small number of students who feel quite agree (26.60%). The main challenge is how to involve these students and motivate them to be more active in vermicompost development. This finding shows the importance of environmental education that involves students in real practice. Educational programs that encourage student participation in vermicompost development can strengthen their commitment and build sustainable skills (Mashur et al., 2001). Visualization of student commitment in developing vermicompost can be seen in Figure 5.

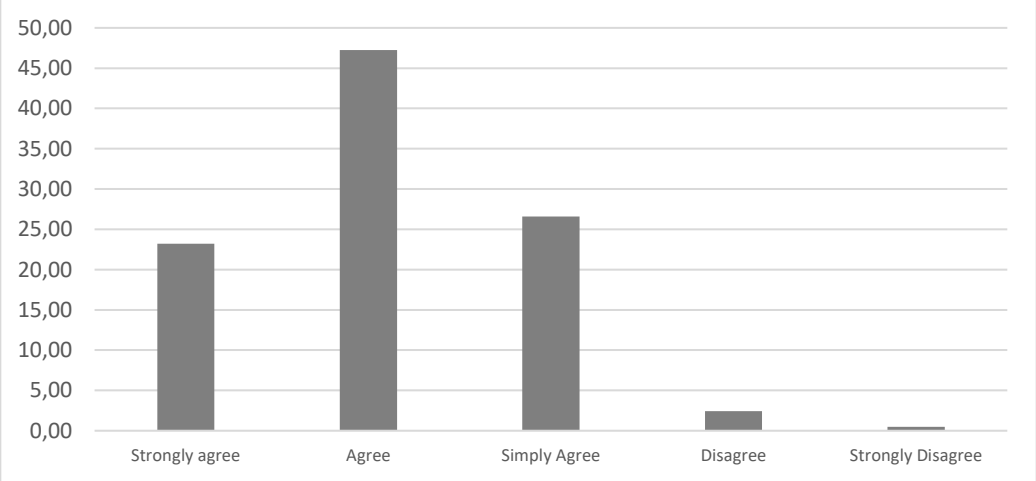

Figure 5. Student's commitment in developing vermicompost.

4. Discussion

4.1 Students Environmental Careness

Based on the results of the research reflect the effectiveness of environmental education and advocacy programs implemented in schools. Schools can play an important role in shaping the character of students who care for the environment. Environmental awareness and environmentally caring character are very important in efforts to protect and preserve the natural environment (Lubis et al., 2022; Fatmah, 2018; Surata, 2019). The results of this research can be used as a basis for continuing to develop environmental education programs in schools. The results of this research show that the majority of junior high school students in Metro City have a positive perception of the character of caring for the environment. This is a positive indication that environmental education and advocacy efforts have been successful in forming an environmentally caring character among students (Lubis et al., 2022). While there is potential for improvement, it provides encouragement to continue strengthening environmental awareness among students for a more sustainable future.

4.2 Student Perceptions of Responsibility

The research results explain the importance of social support in forming a responsible attitude towards environmental problems (Muhfahroyin & Oka, 2017).

Environmental education in schools can play an important role in shaping students' responsible attitude towards environmental issues. These results underscore the importance of effective environmental education programs in increasing awareness and responsibility for environmental issues among students. The results of the study show that most of the students have a responsible attitude towards environmental problems. Although there is still room for improvement, these data provide positive encouragement to continue efforts to increase awareness and responsibility for environmental issues.

Students' responsible attitude towards environmental issues is becoming increasingly important in this modern era, where global environmental challenges are increasingly real. This article discusses the importance of students' responsible attitudes towards environmental issues, the factors that influence them, and the role of education in shaping these attitudes. Our natural environment is increasingly threatened by climate change, pollution, loss of biodiversity, and other environmental problems (Muhfahroyin & Lepiyanto, 2020). In the midst of the current environmental pollution crisis, the attitude of students' responsibility towards environmental problems is very relevant. This attitude includes awareness of environmental problems, the desire to act, and individual responsibility in protecting and preserving the environment.

Education has a key role in shaping students' attitudes towards environmental issues. Effective environmental education programs can increase their awareness and understanding of environmental issues, which in turn influences their attitudes (Muhfahroyin & Oka, 2021). Family and social support also play an important role. When families support responsible environmental practices, students are more likely to have positive attitudes toward environmental issues. Direct experience with nature and the environment can also influence students' attitudes. Outdoor activities and direct experiences with nature can help students develop a sense of responsibility for the environment (Wetering, 2022).

Environmental education in schools has a key role in shaping students' responsible attitude towards environmental issues. Environmental education programs integrated into the curriculum can increase students' understanding of environmental issues, teach them about responsible practices, and encourage them to act in maintaining environmental sustainability (Fatmah, 2018; Khoiri & Hidayati, 2022). Environmental education can help students understand the impact of human actions on the environment and how they can contribute to solving these problems. Thus, environmental education plays an important role in forming students' responsible attitudes towards environmental issues (Calculli et al, 2021). Student responsibility for environmental issues is a valuable asset in an effort to protect and preserve the natural environment. Factors such as environmental education, family support, and personal experiences influence this attitude (Puwanti, 2017). Therefore, effective environmental education in schools can help shape positive attitudes towards environmental issues, which in turn can encourage sustainable action for a better future.

4.3 Students' Perceptions of Vermicompost

However, there are still challenges in increasing students' knowledge about vermicompost. The moderately agree response indicates that there are some students who may need more information or a deeper understanding of this method. Therefore, education about vermicompost can be further expanded and deepened to ensure that students have comprehensive knowledge about this topic. Students' knowledge of vermicompost showed a good level of knowledge, with the majority of students giving positive responses. However, there is still room for improvement in students' understanding of this method (Anggraeni et al., 2022). Broader and in-depth education about vermicomposting can help students become more competent in managing organic

waste and support sustainable efforts. Although the majority of students have good knowledge of this topic, there are still challenges in improving their understanding.

This study can serve as a basis for understanding the role of education in increasing students' understanding of vermicompost and relevant environmental topics. Environmental education plays an important role in increasing students' knowledge about vermicompost. Effective educational programs can provide an understanding of the advantages of vermicompost in managing organic waste and making environmentally friendly compost fertilizer (Fuad, 2016). In addition to formal education at school, practical experience such as managing the vermicompost process at school or at home can give students the opportunity to apply their knowledge in everyday life. This direct experience can strengthen their understanding and encourage positive action in overcoming the organic waste problem (Surata, 2019; Muhfahroyin & Oka, 2021).

4.4 Students' Motivation in Contextual Learning

For students who disagree, it is necessary to pay further attention to the factors that influence students' disagreement with this contextual learning. The results of this research illustrate the importance of increasing student motivation in contextual learning. Although there was some variation in students' perceptions, the majority responded positively to this contextual learning method. Therefore, teachers can better support the use of contextual learning approaches in an effort to increase student engagement and motivation in the learning process. Context-oriented education gives students the opportunity to see the relevance of subject matter to the real world and encourages deeper understanding. By paying attention to student perceptions, this approach can be continually refined and adapted to create more meaningful and inspiring learning experiences for students. It is necessary to understand individual differences and the factors that influence their perceptions of contextual learning methods.

Contextual learning allows students to understand concepts and knowledge in contexts are relevant to their daily lives. This creates a strong connection between theory and practice, changing lessons from something abstract to relevant and meaningful (Surata, 2019). Students tend to be more motivated when they see the relevance of the subject matter to their lives. By linking learning to real world situations, they can see how the concepts learned can be applied in everyday life (Muhfahroyin & Lepiyanto, 2020). Contextual learning allows students to understand concepts in more depth. Not only do they remember information for tests, but they can also reflect on how that information can be used in real contexts (Sailer et al., 2021; Lebreton et al., 2019). Contextual learning encourages active student involvement. They are invited to think, apply concepts and solve problems, not just receive passive knowledge (Skukauskaitė & Girdzijauskienė, 2021). Contextual learning plays a role in increasing student engagement and helping them prepare to face real-world challenges. This approach provides opportunities for students to relate knowledge to their experiences, motivates them to learn more deeply, and develops critical thinking skills (Chang et al., 2020). Through a contextual learning approach, education can become more meaningful and relevant for students, helping them grow into lifelong learners who are ready to face the future.

4.5 Student Commitment to Developing Vermicompost

Through vermicompost, there is an organic composting process involving earthworms. This method is environmentally friendly for breaking down organic waste, producing high quality compost, and reducing the volume of waste that goes to final landfills (Anggraeni et al., 2022). Students' perceptions of their commitment to developing vermicompost reflect their awareness of environmental issues (Khoiri & Hidayati, 2022). It is important for schools and educators to continue to encourage student engagement in sustainable practices such as vermicompost development, and to support students who may need additional encouragement (Shinta & Ain, 2021).

Through this approach, students can experience for themselves how small actions such as developing earthworms can have a big impact in supporting a better environment for the future (Mashur et al., 2001). With strong awareness and commitment, students can play a role in overcoming current environmental problems and supporting a better future.

Overall, the five student perceptions in terms of environmental care character have a good score. This can be seen from the average total score, namely students gave a strongly agree perception of 38.31%, gave an agree perception of 41.06%, gave a somewhat agree perception of 18.19%, gave a disagree perception of 2.04, and strongly disagree by 0.40%. Students' perceptions of their environmentally caring character are influenced by many factors, namely students' knowledge and understanding of human waste and its benefits, their sense of responsibility for environmental sustainability, and students' level of education. Students who understand environmental sustainability and the benefits of fecal sludge have the perception that fecal sludge can be utilized as a contextual learning resource by utilizing a processing process using the vermicompost method.

5. Conclusion

Based on the research, there were five student perceptions regarding their commitment to environmental conservation, consist of strongly agree: 38.31% of students hold this perception. Agree: 41.06% of students. Simply agree: 18.19% of students. Disagree: 2.04% of students. Strongly Disagree: 0.40% of the students. Students' perceptions of their environmental consciousness are depended by several factors, including their knowledge and understanding of waste management and its benefits, their sense of responsibility towards environmental sustainability, and their level of education. Those who comprehend the importance of environmental sustainability and the potential benefits of responsible waste management tend to view fecal sludge as a valuable contextual learning resource.

Authors Contribution: M.M.: research design, methodology, conducting the research and writing original article, field data collection, data analysis, and revision. S. Z.: Field data collection, data analysis, exploring references,and composed the report.

Conflict of Interest: The authors declare that in the research no conflict of interest.

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6. References

Aiken, L. R. (1985). Three coefficients for analyzing the reliability and validity of rating. *Educational and Psychological Measurement*, *45*(1), 131–142. https://doi.org/10.1177/0013164485451012

Anggraeni, A. Y., Raksun, A., & Mertha, I. G. (2022). The effect of vermicompost and npk fertilizer on the growth of green mustard (Brassica juncea L.). *Jurnal Biologi Tropis*, *22*(2), 525–533. https://doi.org/10.29303/jbt.v22i2.3381

Calculli, C., D'Uggento, A.M., Labarile, A., Ribecco, N. (2021). Evaluating people's awareness about climate changes and environmental issues: A case study. *Journal of Cleaner Production. 324*(129244). https://doi.org/10.1016/j.jclepro.2021.129244

Chang, C. Y., Kao, C. H., Hwang, G. J., & Lin, F. H. (2020). From experiencing to critical thinking: a contextual game-based learning approach to improving nursing students' performance in electrocardiogram training. *Educational Technology Research and Development*, *68*(3), 1225–1245. https://doi.org/10.1007/s11423-019-09723-x

Creswell, J. W. (2012). *Educational research* (Fourth Editioan). Pearson.

Fatmah, N. (2018). Pembentukan karakter dalam pendidikan. *IAIT Kediri*, *29*(2), 369–387. http://ejournal.iai-tribakti.ac.id/index.php/tribakti/article/view/

Fitriana, S., Dian, P., & Setiawan, A. (2017). IbM pemanfaatan tinja menjadi pupuk cair organik di Kelurahan Tambakrejo. *Jurnal E-Dimas*, *8*(1), 6–103. https://journal.upgris.ac.id/index.php/e-dimas/article/view/1378

Fuad, A. M. (2016). *Pengaruh kotoran manusia, kascing, rumen dan kompos terhadap ketersediaan Nh 4 +, C-organik dan populasi mikroorganisme pada entisol Kecamatan Krembung, Kabupaten Sidoarjo*. Undergraduate thesis, UPN Veteran Jawa Timur. http://eprints.upnjatim.ac.id/7243/

Hoang, S. A., Bolan, N., Madhubashani, A.M.P., Vithanage, M., Perera, V., Wijesekara, H., Wang, H., Srivastava, P., Kirkham, M.B., Mickan, B.S., Rinklebe, J., Siddique, K.H.M. (2022). Treatment processes to eliminate potential environmental hazards and restore agronomic value of sewage sludge: A review. *Environmental Pollution.* https://doi.org/10.1016/j.envpol.2021.118564

Khoiri, F. F., & Hidayati, Y. M. (2022). Pemanfaatan daun kering untuk menanamkan karakter peduli lingkungan pada peserta didik di sekolah dasar. *Jurnal Basicedu*, *6*(3), 5014–5020. https://doi.org/10.31004/basicedu.v6i3.2999

Lebreton, M., Bacily, K., Palminteri, S., & Engelmann, J. B. (2019). Contextual influence on confidence judgments in human reinforcement learning. *PLoS Computational Biology*, 15(4). https://doi.org/10.1371/journal.pcbi.1006973

Lubis, S.P.W., Muzanna, S.R., Firdausiyah, I. 2020. Profil sikap peduli lingkungan siswa SMA di Aceh. *Jurnal Dedikasi Pendidikan*, 4(1), 34-42. http://jurnal.abulyatama.ac.id/index.php/dedikasi/article/view/558

Mashur, G., Djajakirana, D., Muladno, M., & Sihombing, D. T. H. (2001). Budidaya cacing tanah utk produksi biomasa 2001. *Jurnal Med. Pet*, *24*(2), 28–38. https://doi.org/10.33394/bioscientist.v10i1.5169

Moningka, B., Kumurur, V. A. ;, & Moniaga, I. L. (2015). Analisis pengelolaan lumpur tinja di Kecamatan Sario Kota Manado. *Jurnal Sabua*, *7*(2), 437–445. https://doi.org/10.35793/sabua.v7i2.9588

Mosakhani, M., & Jamporazmey, M. (2010). Introduce critical succes factors (CSFs) of elearning for evaluating e-learning implementation succes. *International Coriference on Educational and Information Technology*. http://dx.doi.org/10.1109/ICEIT.2010.5607745

Muhfahroyin, M., & Lepiyanto, A. (2020). Potensi hutan stadion tejosari kota metro sebagai sumber belajar kontekstual materi keanekaragaman hayati. *Jurnal Lentera Pendidikan, 5*(1), 96-102. http://dx.doi.org/10.24127/jlpp.v5i1.1472

Muhfahroyin, M., & Oka, A. A. (2017). Improving post-graduate students learning activities through lesson study in learning forest-prototype. *Biosaintifika: Journal of Biology & Biology Education*, *9*(2). https://doi.org/10.15294/biosaintifika.v9i2.6208

Muhfahroyin, M., & Oka, A. A. (2021). Analisis kelayakan bahan ajar pencandraan tumbuhan berbasis prototype hutan pembelajaran untuk pembelajaran kontekstual. *Bioedukasi*, *12*(2), 202–213. http://dx.doi.org/10.24127/bioedukasi.v12i2.4449

Naveed, Q. N., Qureshi, M. R. N., Tairan, N., Mohammad, A. H., Shaikh, A., Alsayed, A. O., Shah, A., & Alotaibi, F. M. (2020). Evaluating critical success factors in implementing E-learning system using multi-criteria decision-making. *PLoS ONE*, *15*(5). https://doi.org/10.1371/journal.pone.0231465

Paristiowati, M., Hadinugrahaningsih, T., Purwanto, A., & Karyadi, P. A. (2019). Analysis of students' scientific literacy in contextual-flipped classroom learning on acid-base topic. *Journal of Physics: Conference Series*, *1156*(1). https://doi.org/10.1088/1742-6596/1156/1/012026

Puwanti, D. (2017). Pendidikan karakter peduli lingkungan dan implementasinya. *Dwijacendekia Jurnal Riset Pedagogik*, *14*(20). https://doi.org/10.20961/jdc.v1i2.17622

Sailer, M., Schultz-Pernice, F., & Fischer, F. (2021). Contextual facilitators for learning activities involving technology in higher education: The C♭-model. *Computers in Human Behavior*, *121*. https://doi.org/10.1016/j.chb.2021.106794

Shinta, M., & Ain, S. Q. (2021). Strategi sekolah dalam membentuk karakter siswa di sekolah dasar. *Jurnal Basicedu*, *5*(5), 4045–4052. https://doi.org/10.31004/basicedu.v5i5.1507

Skukauskaitė, A., & Girdzijauskienė, R. (2021). Video analysis of contextual layers in teaching-learning interactions. *Learning, Culture and Social Interaction*, *29*. https://doi.org/10.1016/j.lcsi.2021.100499

Surata, I. (2019). Pendekatan contextual teaching and learning (CTL) berbasis LKS untuk meningkatkan aktivitas biologi. *Bioedusiana*, *4*(2). https://doi.org/10.34289/292826

Undang-undang Nomor 26 Tahun 2007 tentang Penataan Ruang, Pub. L. No. 26, Kemenkumham.

Wetering, J., Leijten, P., Spitzer, J., Thomaes, S. 2022. Does environmental education benefit environmental outcomes in children and adolescents? A meta-analysis. *Journal of Environmental Psychology*. 81 (101782). https://www.sciencedirect.com/science/article/pii/S0272494422000275

Yaashikaa, P.R. , Kumar, P.S., Nhung, T.C., Hemavathy, R.V., Jawahar, M.J., Neshaanthini, J.P., Rangasamy, G. (2022). A review on landfill system for municipal solid wastes: Insight into leachate, gas emissions, environmental and economic analysis. *Chemosphere. 309(1) 136627.* https://doi.org/10.1016/j.chemosphere.2022.136627