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Development and Validation of Online Survey Instrument on Sustainable Development for Science Teachers: Focus on Pili (*Canarium ovatum*)

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ABSTRACT
Teachers are the frontline workers in sustaining quality education; hence, assessing their knowledge, attitudes, and behaviors (KAB) allows them and the administrators to create better training, programs, and instructional materials. The objective is to develop and validate a quick and accessible online instrument to assess the teachers' KAB towards sustainable development in the Philippine context, as part of a bigger project to integrate Pili (*Canarium ovatum*) into education. The researchers administered the instrument using a cross-sectional survey method through Google Forms in which respondents (n = 206) had voluntarily answered. The 24-item tool, anchored on the 2030 sustainable development goals and their complex systems, is reliable and valid based on the confirmatory factor analysis, and Cronbach's alpha and Fleiss's kappa estimates. The results showed that having favorable knowledge and attitudes toward sustainable development is inadequate to create positive behaviors. The adaptation of the developed instrument, the use of findings for intercultural and cross-cultural studies, and further investigations are recommended.

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Introduction

The emerging presence of the unavoidable and unforeseen risks makes the world more challenging for survival. As people work to meet their needs, maintaining the harmonious relationship between the economy, society, governance, and environment is important, prompting the creation of sustainable development goals. Sustainable development (SD) pertains to the process of advancements that meets the necessities of the present population without depriving the future generations' capacity to produce their own resources (Brundtland, 1987). It is composed of four interacting complex systems: economic development, social inclusion, Earth's physical systems, and good governance. The balance among these systems needs to be considered in successfully addressing sustainability issues (Sachs, 2015). Furthermore, The United Nations Conference on Environment and

Development (UNCED) and the World Commission on Environment and Development (WCED) consider education as a crucial component for greater sustainability and a more sustainable world (UNCED, 1992; WCED, 1987). Taking these principles into consideration, several organizations such as the United Nations Educational, Scientific and Cultural Organization (UNESCO) have been aggressively promoting the integration of SD in the education of youth, as they are expected to become leaders of future generations and make positive changes in the society (UNESCO, 2014; 2018). These notions provide the groundwork for the development of Education for Sustainable Development (ESD). ESD aims to address the changing educational demands and empower students to make informed decisions and responsible actions to meet their needs while balancing the interacting complex systems of SD (UNESCO, 2014).

ESD was established and has been widely recognized as a key enabler to achieving the 2030 SD agenda and as an integral element of quality education (UNESCO, 2018). There are several views and definitions of quality education in which UNESCO (2004) emphasized two basic principles as an indicator of its success: (1) improvement of learner's cognitive abilities; and (2) emphasis on the values and attitudes of responsible citizenship and the nurturing of creativity and emotional development. Teachers play significant roles in educating the youth and accomplishing the criteria of quality education. Hence, they need to understand SD and ESD before teaching them to their students. Moreover, their profound acknowledgment of their knowledge, attitudes, and behaviors (KAB) toward SD, taking the four interacting complex systems into account, is necessary to effectively implement ESD and eventually help in achieving quality education and a higher standard of living (Al-Naqbi & Alshannag, 2018; Hanifah, 2020; McKeown, 2002). To this end, measuring their KAB on SD is a vital step that would guide the administrators and the curriculum designers in planning, before implementing ESD.

Literature Review

A conceptual framework for KAB towards SD through ESD

In this study, *knowledge* pertains to the beliefs and ideas toward SD, *attitudes* refer to the feelings and emotions toward SD, and *behavior*s refer to the actions and practices relevant to SD. To elaborate further, the researchers adapted the definition of KAB from the study of Schrader and Lawless (2004). They defined knowledge in three forms – declarative (knowing what), procedural (knowing how), and conditional (knowing when and why). They also defined attitudes in three forms – cognitive (beliefs or ideas), affective (evaluation and emotions), and conative (overt actions or predispositions). Lastly, they described behavior as an observable action.

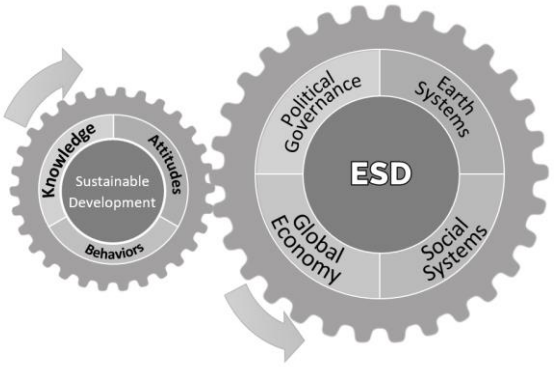
The relationship between knowledge, attitudes and behaviors towards SD is a significant factor in the implementation of ESD, considering the balance among the four interacting complex systems of SD. According to Bamberg and Möser (2007), knowledge is not enough to manifest environmentally favorable attitudes and behaviors. Likewise, according to Al-Naqbi and Alshannag (2018), knowledge and attitudes are not sufficient to elicit positive behaviors. Further, based on the study of Borges (2019), KABs are significantly associated with one another; strong association between knowledge and attitudes, weaker for knowledge and behaviors, and weakest for attitudes and behaviors. Several studies suggested that favorable KAB leads to economic, social, and environmental sustainability (Amézaga et al., 2021; Gusti, 2016; Heeren et al., 2016; Michalos et al., 2012, Michalos, Kahlke, Rempel et al., 2015). Given the findings from previous studies, the current researchers perceived that although there may be different levels of association among these domains, together, they are valuable drivers to successfully implementing ESD. Hence, efforts to improve them towards achieving SD are imperative. To illustrate the importance and contribution of this study, the researchers developed a conceptual framework as shown in Figure 1.

Conceptual frameworks are presented in many forms, primarily diagrams, that clearly convey the structure of the study and are used to define the connection of various concepts within a certain

research study (Çepni, 2021). Figure 1, the conceptual framework for KAB towards SD as drivers of ESD, shows that the association of the knowledge, attitudes, and behaviors towards SD is an important aspect of promoting ESD, emphasizing the balance among the four interacting complex systems. In this sense, to achieve favorable KAB towards SD, a preliminary study to assess the current KAB of the target population is imperative. This assessment serves as baseline data that is essential to guide the researchers in pursuing bigger research studies in the future. One of the ways to do a preliminary investigation is by measuring the teachers' KAB towards SD through surveys using self-assessment instruments.

Figure 1

A Conceptual Framework for KAB towards SD as Drivers of ESD



Contextualizing Self-Assessment Survey Instruments for SD

Survey instruments that measure KAB may reveal misconceptions or misunderstandings that would in turn unveil hindrances and potential barriers to program implementations and behavioral changes (du Monde, 2011). Therefore, these surveys are important to prepare and address the potential problems as early as possible. Various studies have been conducted along with the development of tools to assess teachers' KAB on SD. Borges (2019) developed a 5-point Likert scale tool with 41 items for Portuguese preservice elementary teachers. Al-Naqbi and Alshannag (2018) developed a 5-point Likert scale e-questionnaire with 70-items for tertiary students, including preservice secondary teachers, in the United Arab Emirates. Yang et al. (2010) developed a 32-item instrument to assess the values and teaching beliefs of secondary teachers in China. Zyadin, et al. (2014) developed a questionnaire to evaluate the KAB towards SD on renewable energy of secondary teachers in Jordan. The abovementioned researchers chose to develop and modify instruments to assess and evaluate SD in the context and culture of their respective countries. Developing their own instruments allows them to gather significant information and diagnose the local situations relevant to SD.

In the case of the Philippines, Barloa et al. (2016) developed and validated an instrument to explore the knowledge, attitudes, and practices on SD of undergraduate students, specifically on solid waste management. Montebon (2018) developed and validated a tool to investigate the preservice science teachers' concept of SD and its integration into their lessons. Debrah et al. (2021) included the Philippines among the developing countries to raise awareness of solid waste management through formal education. Aside from these studies, the Philippine educational system supports the promotion and integration of SD at the higher and basic levels by creating projects such as eco-friendly schools, disaster risk reduction programs, and climate change, among others (Valencia, 2018). However, to the understanding of the present researchers, studies on the KAB towards SD of science teachers in the Philippine secondary schools are limited. Thus, studies focusing on these variables are significant to add to the existing studies on SD in the Philippine context and eventually help in profoundly

understanding SD and ESD as a whole. Furthermore, the findings of this study would contribute to the existing body of knowledge that would, in turn, facilitate relevant intercultural and cross-cultural research studies pertinent to SD and education. In this way, other researchers may analyze the similarities and variations in how one culture's integration of education toward SD differs from another.

Although several studies on the development and validation of self-assessment evaluation tools in SD have been conducted, studies on the research instruments are still recommended to add to the variety of tools that can be used by other researchers to comprehensively understand SD (Cebrián et al., 2020; Cebrián et al., 2019, Michalos, Kahlke, Rempel et al., 2017). Thus, the researchers developed and validated an instrument that exhibits the four interacting complex systems of SD, which aims to measure the secondary science teachers' KAB on SD as applied in the Philippine context. The results from this instrument may serve as bases for teachers, instructional designers, and administrators to develop programs and policies fit for teachers' improvement in the learning and teaching process of SD, particularly in the local settings.

In addition, the advancement of technology has caused changes in the way researchers conduct their surveys. To get the best result and maximize the quality and the number of responses, Hunter (2012) suggested that online surveys or e-questionnaires should be convenient, quick, and easy to access. Online surveys do not only make gathering data easier, but they also ensure the respondents' health safety during a pandemic (e.g., COVID-19 pandemic) (Funa & Talaue, 2021). Considering these recommendations, the development and validation of a short, quick, convenient, and accessible self-assessment instrument to evaluate the KAB on SD are deemed important. Hence, the researchers considered these characteristics in developing the contextualized online self-assessment instrument in this study.

Pili (Canarium ovatum): A Suitable Context for SD in the Philippines

One of the Philippine products that need special attention is the Pili (*Canarium ovatum*) which is popularly known as the "Tree of Hope" (see Figure 2). Pili is endemic in the Bicol region particularly in Albay, Sorsogon, and Samar, making these places the center of its genetic diversity and major producers of Pili products (Millena & Sagum, 2018).

Figure 2

Photograph of Pili (Canarium Ovatum)

Note: A bunch of Pili fruits of two colors: green and dark purple. Young Pili fruits are green, then they turn dark purple, violet, or black when they mature. Photographed by Cedrick Vincent Gallanosa in 2021 at Bulusan lake, Sorsogon, Philippines.

Several products can be manufactured from Pili and the most popular are confectioneries, pharmaceuticals, and fragrances. Pili nuts could be an alternative to internationally marketable nuts such as almonds and macadamia and Pili oil could be a cheaper alternative to olive oil, particularly in terms of healthy fatty acids (Catelo & Jimenez, 2016). There was an increase of 40.45% in the volume of exports with 46.86% in value of Pili per year from 2008 to 2013. Countries patronizing Pili products

include Canada, the USA, Bahrain, Japan, Norway, and Germany (Catelo & Jimenez, 2016). The potential of Pili in the domestic and international markets only shows the importance of improving a globally competitive industry for Pili. Hence, the local government of the Bicol region has been putting in efforts to promote, improve, innovate, and sustain Pili resources and products (e.g., the Sorsogon Pili Roadmap and the Pili Niche Centers in the Regions for Research and Development [Pili NICER] program). However, despite the potential of Pili as an economic driver in the Bicol region, the interest given by the locals is little, resulting in a waste of economic opportunity and the death of the millennium-age traditional Pili farming in Bicol (Sorsogon pili Roadmap, 2018).

The Bicolano youths' interest in traditional Pili farming which has been one of the Bicolanos' historical occupations is alarmingly declining. Many of the children of Pili farmers are pursuing different professions, trying to secure white-collar jobs, or get employed as construction workers and call center agents, leaving their parents with no choice but to sell their Pili farms and cease Pili farming (Sorsogon Pili Board, 2018; Sorsogon Pili Roadmap, 2018). As a result, there is a diminishing labor force for the Pili industry. Aside from this, there is also a decreasing number of local agriculturists and scientists who are interested in Pili research and development projects. There are only a small number of research studies and technologies which have been conducted and developed to aid the Pili industry. As well as a few research publications, research instruments, and other scientific articles about the status of the Pili industry in the region. Considering these concepts, a complete understanding and promotion of Pili are imperative, making it a suitable context for investigating SD in the Philippines. Thus, an instrument that would help in examining the KAB of teachers towards SD, focusing on Pili, is deemed significant. This instrument would aid in obtaining baseline data that, in turn, may help teachers in integrating Pili and contextualizing different educational programs, activities, and instructional materials based on the Philippine culture. In addition, although the instrument in this study is contextualized to the Philippine culture, the findings and results would be valuable in comparing cultural diversities in integrating SD in education across different places and countries.

Research Questions

This study provides information on the associations among knowledge, attitudes, and behaviors as a driver to promoting and integrating education towards SD. Likewise, results from this study offer the researchers preliminary information on the science teachers' KAB towards the SD of Pili. The purpose is to develop and validate a contextualized quick and easy-to-access self-assessment online survey instrument that is empirically designed to demonstrate the four interacting complex systems of SD and aimed to evaluate the KAB of secondary science teachers towards SD, focusing on Pili (*C. ovatum*) in the context of the Philippines. This developed instrument was part of a bigger research study to promote the concept of Pili sustainability among the youth through ESD. It was administered to answer the following research questions: (1) does the developed instrument achieve validity in terms of construct, face, and content? (2) is the developed instrument reliable? (3) what are the results of the application of the developed instrument, in terms of the respondents' answers for each item, level of KAB, and association among the different domains of KAB?

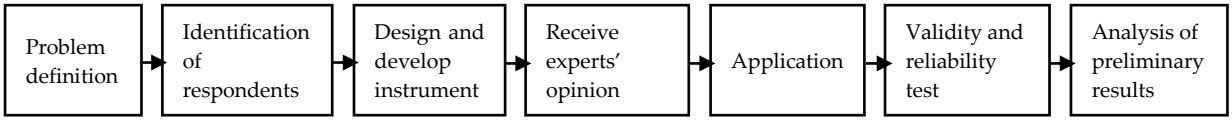
Methods

Research Design

The researchers employed type 1 developmental research to design, create, and scientifically evaluate the developed research instrument, satisfying the conditions of validity and internal consistency. Type 1 developmental studies cover not only the product design and development, but also its evaluation, which sometimes includes the evaluation of a certain design, technique, or research instrument (Richey & Klein, 2005). The research process is shown in Figure 3 to better illustrate the different stages of instrument development in this study.

Figure 3

Research Process on Instrument Development



As seen in Figure 3, the researchers began by emphasizing the critical nature of building a research instrument for SD. The problem was defined in detail in the introduction and review of related literature. The researchers then chose respondents and designed and developed the research instrument. The instrument was designed and developed in response to the study's problem, purpose, and target respondents. The experts in the field, comprised of teachers with experience in science education and SD, initially examined the instrument's draft version. Before application, the instrument was revised based on expert opinions. Following the revision, the instrument was resubmitted to the expert for re-evaluation. After the experts approved the instrument, it was administered online through Google Forms to collect responses for validity and reliability testing. The results of the application were analyzed. This procedure of instrument validation is important prior to broad use in order to ensure the accuracy and completeness of the data and to determine if the instrument consistently measures what it was designed to measure (Fitzner, 2007; Funa & Ricafort, 2019).

Study Group

Science teachers (n = 206) voluntarily answered the online survey questionnaire. Although online surveys entail convenience for both the researchers and the respondents, one of their disadvantages is the low response rate, given that the participation is voluntary (Hunter, 2012). As a result, only a small number of science teachers have responded, despite the questionnaire being accessible for one month. The researchers have decided to end the survey because of declining response rates and the absence of answers during the last week of the survey. In addition, the researchers removed three respondents in analyzing the data because two of them were not teaching science and the other one was not from the Bicol region. This has led to 206 total science teachers, representing the population of secondary science teachers in the Bicol region who are knowledgeable and have directly encountered Pili (*C. ovatum*). Table 1 shows the profile of the respondents.

Table 1

Profile of the Respondents (n = 206)

Demographic profile	Frequency	Percentage
Gender		
Female	148	72
Male	58	28
School/Institution		
Public	187	91
Private	19	9
Major/Specialization		
Biology	72	35
Physics	59	29
Earth Science	35	17
Physical Science	15	7
Chemistry	14	7
General Science	11	5

Junior High School (JHS)	126	61
9	40	19
10	33	16
8	27	13
7	26	13
Senior High School (SHS)	80	39
11	55	27
12	25	12

Most of the respondents are female (72%), public school teachers (91%), Biology majors (35%), and teaching in JHS (61%). The respondents' demographic profile may be affected by the linkages of the researchers in the field. Answering the survey is fully voluntary. As a result, considering the peoples' intrinsic motivation on social media to answer the survey is imperative. Furthermore, some people are afraid of clicking links shared on social media because they may think that the link is a spam or a computer virus (Hunter, 2012). Consequently, these factors affected the number and profile of the respondents.

The Instrument

The researchers developed a tool named, Online Survey Instrument on Sustainable Development of Pili (OSISDeP), which is composed of three major parts: the letter to the respondents, the respondents' demographic profile, and the test on the SD of Pili (*C. ovatum*). First, the letter to the respondents includes the purpose of the study, the information confidentiality statement, and the consent stating the Philippine data privacy act of 2012 and their voluntary participation. Second, the respondents' demographic profile includes questions on personal information such as gender, type of school/institution, major/specialization, and their grade level assignment. Third, the test on SD of Pili; a 4-point Likert scale; 4 (*strongly agree*), 3 (*agree*), 2 (*disagree*), 1 (*strongly disagree*), that includes 24-item statements divided equally into three parts: Knowledge, Attitudes, and Behaviors. The researchers preferred an uneven scale to polarize responses more clearly and avoid moderacy response bias as undecided people often choose the middle point (Bogner & Landrock, 2016; Waltner et al., 2019).

The researchers identified and categorized the items in the questionnaire based on the various literature pertaining to KAB towards SD (Al-Naqbi & Alshannag, 2018; Borges, 2019; Michalos, Kahlke, Rempel et al., 2017; Yang et al., 2010; Zyadin, et al.,2014). Wherein, the knowledge part is constructed according to the beliefs about SD; the attitude part is constructed according to the feelings and emotions towards SD and the last part, the behavior, is constructed based on the actions and practices that promote SD. The items were constructed based on the literature and modified relevant to the target respondents as recommended by Schrader and Lawless (2004) that self-report survey items should be known to respondents. These items were summarized according to the four interacting complex systems. As a result, the items in each part – KAB – can be divided further into four interacting complex systems. For instance, in the first part, item number one, "The promotion of Pili business in the community helps the poor," may refer to the economy as it tackles business, however, it may also refer to governance as it tackles the promotion of a program in the community. Another example is item number three, "The sustainable development of Pili could help women in the community to earn money," which may refer to gender equality and women empowerment and, at the same time, may refer to the economy. However, the study did not investigate the categorization of items along with the four interacting complex systems deeper and is only limited to the classification of items into KAB.

The OSISDeP was made using Google Forms and was then disseminated and shared via e-mail and social media platforms (e.g., Facebook and messenger). The link to the instrument was made accessible for one month. The researchers gathered the data during the time of the COVID-19 pandemic. Choosing online data-gathering procedures ensures the respondents' health safety as they complete the survey questionnaire from home (Funa & Talaue, 2021). The data obtained from this

instrument were used to evaluate its reliability and construct, content, and face validity, as well as to initially examine the KAB of science teachers in the Bicol region as a result of the application as discussed in the succeeding parts of this paper.

Data Collection

Before disseminating the Google Forms link to the target respondents, the experts, comprising of five secondary and tertiary science teachers who are knowledgeable on SD and Pili (*Canarium ovatum*), evaluated the instrument. The first experts' evaluation of the OSISDeP is necessary for corrections and adjustments. After the revision of the OSISDeP and the approval of experts for application, the researchers disseminated the link to the target respondents via e-mail, Facebook page, and messenger, employing a cross-sectional survey method. The respondents who voluntarily answered the survey instrument were afterward asked to share the link with other high school science teachers in the Bicol region. The link was accessible for one month to give enough time for the respondents to answer the survey. Data from the survey were examined and used to test the validity and reliability of the instrument. Moreover, they were analyzed to obtain initial findings from the application of the instrument.

Data Analysis

To quantitatively analyze the obtained data and answer the first research question, the researchers employed exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). These analyses are imperative to identify the duplication and redundancy among items and whether they fit within the domains (knowledge, attitudes, and behaviors) accordingly. Further, having the OSISDeP evaluated by a different set of experts for the second time, Fleiss's kappa was measured to obtain the inter-rater agreement among them. To answer the second research question, the researchers measured Cronbach's alpha to obtain the internal consistency among items. Lastly, to answer the third research question, the researchers used descriptive statistics such as mean, standard deviation, percentage, frequency, and ranking to describe the obtained data from the application of the OSISDeP – a 4-point Likert scale questionnaire: 4 (*strongly agree*), 3 (*agree*), 2 (*disagree*), 1 (*strongly disagree*). Individual scores were then grouped by the range of percentages as follows: (a) a score of less than 60% indicates a low KAB, (b) a score of between 60% and 80% indicates a moderate KAB, and (c) a score of more than 80% to 100% indicates a high KAB. On the other hand, the researchers employed Pearson's Chi-square test to evaluate the connection among the different domains of KAB.

Results and Findings

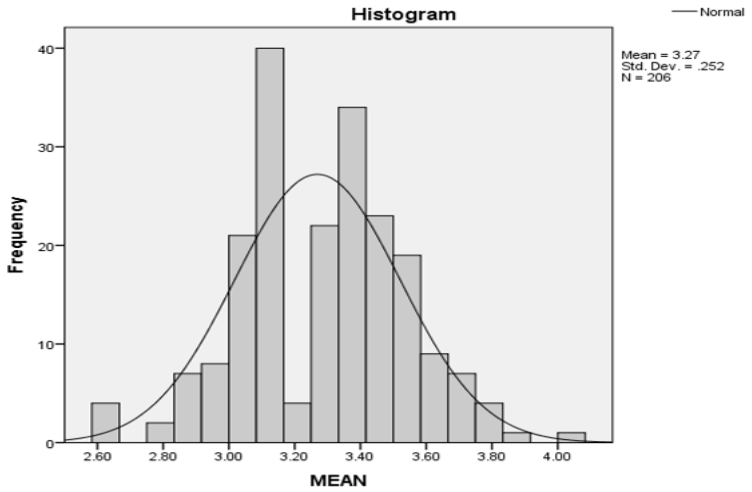
The researchers presented the results and findings in chronological order with the identified research questions and a systematic discussion of the statistical analyses. This part of the paper shows the process of confirming the reliability and validity of the developed self-report online survey instrument and analysis of the preliminary application of the developed instrument.

The Construct, Face, and Content Validity of the Developed Instrument

Prior to the factor analysis, assumptions must be met first. The researchers conducted a normality test and standardized skewness of the data. The results of normality test show that the Kolmogorov-Smirnov coefficient is significant (D (206) = .085, $p < .05$), while the Shapiro-Wilk is not significant (W (206) = .987, $p > .05$). Based on Razali and Wah (2011), Shapiro-Wilk is the most powerful normality test. Therefore, the researchers considered the value of Shapiro-Wilk instead of the Kolmogorov-Smirnov estimates, indicating that the data are normally distributed. To visualize the normality of the data, see Figure 4.

Figure 4

Normal Distribution Curve



Note: A histogram showing the normal distribution curve of the science teacher's responses to the conducted study.

Figure 4 presented the histogram showing the normal distribution curve of the science teachers' responses along with the items on the developed instrument (M = 3.27, SD = .252), with the skewness of -.009 (SE = .169) and kurtosis of -.021 (SE = .337). The normality tests suggest that the researchers may continue to the next steps, that is, the Kaiser-Meyer-Olkin (KMO) and Bartlett's tests.

The KMO and Bartlett's tests are needed to verify the suitability of the data for factor analysis (Ugulu, 2015). The KMO value between .8 and 1 indicates that the sampling is adequate (Dodge, 2008; Russell, 2002) and Bartlett's test significant result indicates rejection of the null hypothesis and homogeneity of variances among all samples (Snedecor & Cochran, 1989). The study obtained a KMO of .80 and a Bartlett's value of χ^2 (276) = 2524.30, $p < .05$. These results indicate that the assumptions for doing the EFA on OSISDeP have been met. Table 2 shows the results of EFA.

Table 2

Exploratory Factor Analysis Results for OSISDeP

OSISDeP Items	*M*	(*SD*)	Rotated Factor Loading		
			1	2	3
1. The promotion of the Pili business in the community helps the poor.	3.68	0.47	.567		
2. The sustainable development of Pili involves minimizing wastes.	3.63	0.48	.601		
3. The sustainable development of Pili could help women in the community earn money.	3.74	0.46	.767		
4. Planting Pili trees contribute to a better climate system.	3.88	0.32	.310		.406
5. The sustainable development of Pili supports different cultural values in the Bicol region.	3.78	0.45	.568		
6. The sustainable development of Pili promotes the use of renewable energy in manufacturing Pili products.	3.70	0.46	.706		
7. Allotting part of the Pili business's income for services that care for the environment is needed for Pili sustainability.	3.75	0.43	.594		.384
8. The sustainable development of Pili involves improving the people's understanding of Pili.	3.76	0.43	.586		.339
9. I would be happy to see people who understand the importance of Pili sustainability in preserving the culture of Bicol.	3.90	0.30	.400		.462
10. I get angry when Pili manufacturers are not encouraging zero-waste Pili production.	3.52	0.56			.715

11. I get annoyed when people are ignoring threats to Pili conservation.	3.57	0.59			.729
12. I get happy whenever I see news about stricter laws that protect Pili trees in the Bicol region.	3.78	0.41	.345		.550
13. I admire people who invest in Pili to lessen poverty in Bicol.	3.86	0.35	.411		.418
14. I get mad at people exploiting Pili resources.	3.59	0.57			.542
15. I get happy when the government encourages the use of renewable energy in Pili production.	3.83	0.37	.664		.358
16. I am happy to hear that Pili production also promotes gender equality.	3.67	0.53	.339		.370
17. I use Pili as an example in classroom discussions.	2.51	0.72		.549	
18. I buy Pili products from local producers.	3.31	0.66		.370	
19. I attend seminars on the sustainable development of Pili.	1.84	0.68		.736	
20. I talk to people about how Pili could help lessen poverty.	2.13	0.68		.709	
21. I think about saving Pili from environmental deterioration.	2.83	0.73		.572	
22. I coordinate with the government to plant Pili trees.	1.98	0.72		.733	
23. I read studies on converting Pili wastes into useful materials.	2.35	0.76		.644	
24. I volunteer to work for organizations involving Pili sustainability.	1.85	0.70		.750	

The researchers performed an EFA that used a Varimax rotation method set at three factors to determine the connection of the observed variables to the teachers' KAB towards SD of Pili. The items were distributed into eight items for each factor, as follows:

(1) Knowledge (items 1-8). Despite item 4 being higher on factor 3 than on factor 1, it was grouped in factor 1 because it was constructed for the knowledge rather than the attitude.
(2) Attitudes (items 9-16). Regardless of item 15 being higher on factor 1 than on factor 3, it was grouped in factor 3 because it is about attitudes rather than knowledge.
(3) Behaviors (items 17-24).

Moreover, as shown in Table 2, the rotated factor values ranged between .300 and .767. Items with factor loadings lower than .30 are not reported. The highest eigenvalue was considered in loading the factors, except for items 4 and 15. These results of the EFA have verified the allocation of items for each factor, confirming the construct validity of the OSISDeP.

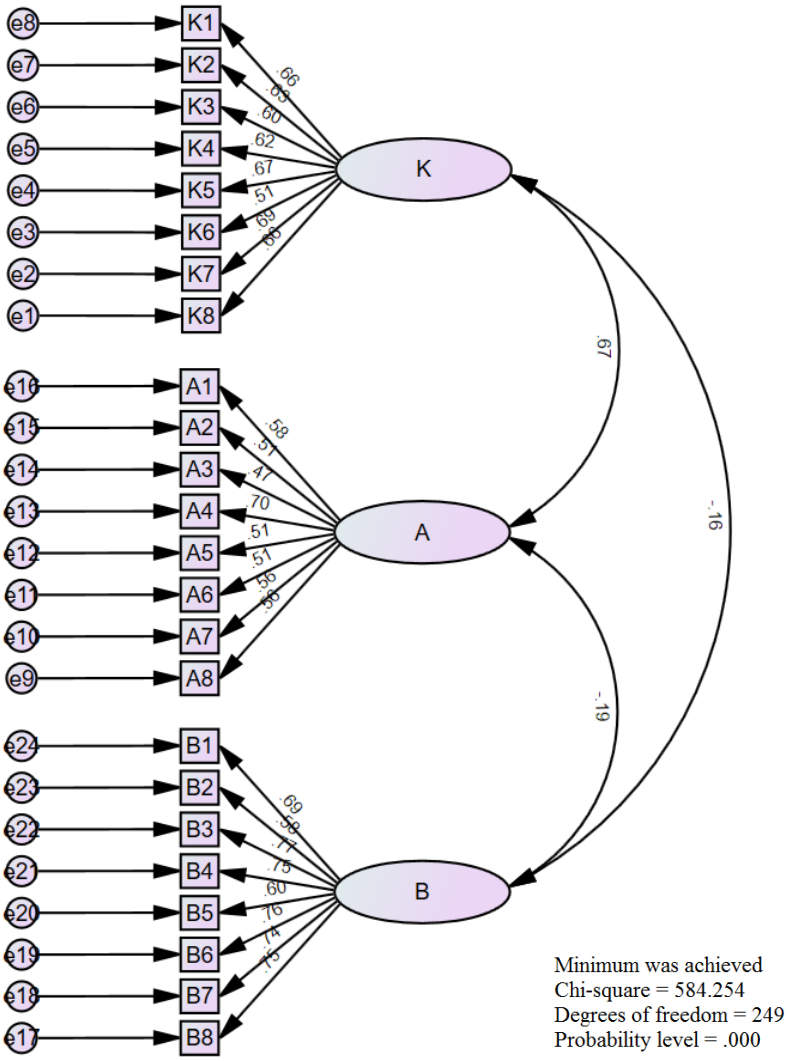
The researchers conducted CFA using the generated factors from the EFA to confirm if the items fit within each factor identified. The results showed that the Chi-Square statistic is significant ($p < .005$), which entails that the items assigned in each factor are not fit. However, according to Hooper et al. (2008), Chi-square as a basis for evaluating the model fit is sensitive to sample size that nearly always rejects model when used in large sample sizes. Hence, the researchers consider other parameters to determine the model fit of the OSISDeP such as the root mean square error of approximation (RMSEA), standardized root mean square (SRMR), comparative fit index (CFI), and parsimonious normed fit index (PNFI) as recommended by Hooper et al. (2008). The CFI value of .820 is indicative of not fit or misspecified items, which may be due to the consideration given to the items 4 and 15 from the conducted EFA above; hence, improvement of the OSISDeP in future studies is advised. Nevertheless, the researchers continue because the RMSEA value of .080 and SRMR value of .0685 are within the range for adequate fit, which is ≤ .08 (Asparouhov & Muthén, 2018; Hooper et al., 2008). The value of PNFI is .656. PNFI has no threshold levels (Hooper et al. 2008); however, reporting of parsimony fit indices along with other measures of goodness-of-fit is recommended. The factorial model of the OSISDeP was shown in Figure 5.

The researchers run Fleiss's kappa to obtain the inter-rater agreement among the experts with relevance to the content and face validity of the OSISDeP. To do this, a secondary evaluation of the OSISDeP by a different set of experts after the items have been grouped according to the identified factors was carried out. There are three experts composed of high school science teachers who are knowledgeable about the SD of Pili in the Bicol region. They evaluated the content and face validity of the OSISDeP. On one hand, the content validity includes the following items: (1) the questions are suitable to the respondents' level of understanding; (2) the content of the instrument is free of biases; (3) the content of the instrument has the potential to stimulate interest; (4) the content of the instrument manifests correct data and information; (5) the instrument can be used to measure the

respondents' knowledge fundamental to Pili sustainability; (6) the instrument can be used to determine the respondents' attitudes significant to Pili sustainability; and (7) the instrument can be used to determine the respondents' behaviors towards the promotion of Pili sustainability. On the other hand, the face validity includes the following items: (1) the language used is easily understandable; (2) the language used is correct and appropriate; (3) the size of letters is readable; (4) the spaces between words and letters facilitate reading; and (5) the font style used is readable. Then, the researchers used the Online kappa calculator by Randolph (2008) to generate Fleiss's kappa values. Both the content and the face validity category obtained very good agreement among experts, $\kappa = 1.00$ (95% *CI*, -1.00 to 1.00), confirming the content and face validity of the developed instrument.

Figure 5

Confirmatory Factor Analysis Model of the OSISDeP



Note: K stands for knowledge, A is for attitudes, and B is for behaviors.

The Reliability of the Developed Instrument

The results of exploratory factor analysis and Fleiss's kappa verified the construct, content, and face validity of each dimension and item in the OSISDeP. Likewise, to analyze the reliability of the OSISDeP, the researchers obtained the descriptive statistics, eigenvalues, variance percentages, and Cronbach's alpha estimates as shown in Table 3.

Table 3

Descriptive Statistics Mean (M) and Standard Deviation (SD), Eigenvalue, Percentage of Variance, Cronbach's Alpha (reliability) (n = 206)

OSISDeP factors	*M*(*SD*)	Eigenvalue	Variance (%)	Cronbach's alpha
(1) Knowledge	3.74(.308)	6.687	27.862	.852
(2) Attitudes	3.72(.321)	1.698	7.075	.835
(3) Behaviors	2.35(.484)	3.866	16.106	.839
Total	3.27(.252)		51.043	.835

As presented in Table 3, the factors explained 51.043% of the total variance. The researchers used Cronbach's alpha to determine the reliability of each factor and the overall developed instrument (OSISDeP). Cronbach's alpha estimate of .84-.90 is considered to be reliable (Taber, 2018). Hence, the obtained values suggest that each factor on its own and the overall instrument are considered reliable (α = .835).

Results of the Developed Instrument Application

In addition to the validity and reliability tests, the researchers analyzed the level of KAB from the respondents' answers to this study. Based on their responses, science teachers' KAB obtained mean averages of 3.742 (*SD* = .308), 3.716 (*SD* = .321), and 2.34 (*SD* = .484), respectively, as shown in Table 3. This data suggests that the secondary science teachers in the Bicol region have favorable knowledge and attitudes towards the SD of Pili (*Canarium ovatum*). However, with the positive scores for knowledge and attitudes, the behaviors obtained a fair score. This result parallels the findings of Al-Naqbi and Alshannag (2018) and Borges (2019) in which preservice teachers obtained high scores on knowledge and attitudes, but lower scores on behaviors, suggesting the presence of difficulties in the adoption of behaviors. This means that having good knowledge and positive attitudes are not sufficient to generate good behaviors. Thus, various opportunities to explicitly show and develop positive behaviors towards SD are imperative (Amran et al., 2019; Borges, 2019). To investigate further, the researchers obtained the frequency and percentage of responses for every item in each dimension as shown in Table 4.

Table 4

Results of the OSISDeP Preliminary Application

Dimension	Items	SA *n* (%)	A *n* (%)	D *n* (%)	SD *n* (%)
Knowledge	K1. The promotion of the Pili business in the community helps the poor.	140 (68.0)	66 (32.0)	0 (0.0)	0 (0.0)
	K2. The sustainable development of Pili involves minimizing waste.	129 (62.6)	77 (37.4)	0 (0.0)	0 (0.0)
	K3. The sustainable development of Pili could help women in the community earn money.	155 (75.2)	49 (23.8)	2 (1.0)	0 (0.0)
	K4. Planting Pili trees contribute to a better climate system.	182 (88.3)	24 (11.7)	0 (0.0)	0 (0.0)
	K5. The sustainable development of Pili supports different cultural values in the Bicol region.	164 (79.6)	39 (18.9)	3 (1.5)	0 (0.0)
	K6. The sustainable development of Pili promotes the use of renewable energy in manufacturing Pili products.	145 (70.4)	61 (29.6)	0 (0.0)	0 (0.0)
	K7. Allotting part of the Pili business's income for services that care for the environment is needed for Pili sustainability.	155 (75.2)	51 (24.8)	0 (0.0)	0 (0.0)

	K8. The sustainable development of Pili involves improving the people's understanding of Pili.	157 (76.2)	49 (23.8)	0 (0.0)	0 (0.0)
Attitudes	A1. I would be happy to see people who understand the importance of Pili sustainability in preserving the culture of Bicol.	186 (90.3)	20 (9.7)	0 (0.0)	0 (0.0)
	A2. I get angry when Pili manufacturers are not encouraging zero-waste Pili production.	114 (55.3)	86 (41.7)	6 (2.9)	0 (0.0)
	A3. I get annoyed when people are ignoring threats to Pili conservation.	127 (61.7)	69 (33.5)	10 (4.9)	0 (0.0)
	A4. I get happy whenever I see news about stricter laws that protect Pili trees in the Bicol region.	161 (78.2)	45 (21.8)	0 (0.0)	0 (0.0)
	A5. I admire people who invest in Pili to lessen poverty in Bicol.	177 (85.9)	29 (14.1)	0 (0.0)	0 (0.0)
	A6. I get mad at people exploiting Pili resources.	130 (63.1)	68 (33.0)	8 (3.9)	0 (0.0)
	A7. I get happy when the government encourages the use of renewable energy in Pili production.	172 (83.5)	34 (16.5)	0 (0.0)	0 (0.0)
	A8. I am happy to hear that Pili production also promotes gender equality.	143 (69.4)	57 (27.7)	6 (2.9)	0 (0.0)
Behaviors	B1. I use Pili as an example in classroom discussions.	18 (8.7)	79 (38.3)	100 (48.5)	9 (4.4)
	B2. I buy Pili products from local producers.	86 (41.7)	98 (47.6)	22 (10.7)	0 (0.0)
	B3. I attend seminars on the sustainable development of Pili.	1 (0.5)	30 (14.6)	110 (53.4)	65 (31.6)
	B4. I talk to people about how Pili could help lessen poverty.	7 (3.4)	42 (20.4)	128 (62.1)	29 (14.1)
	B5. I think about saving Pili from environmental deterioration.	37 (18.0)	99 (48.1)	67 (32.5)	3 (1.5)
	B6. I coordinate with the government to plant Pili trees.	5 (2.4)	35 (17.0)	116 (56.3)	50 (24.3)
	B7. I read studies on converting Pili wastes into useful materials.	16 (7.8)	60 (29.1)	110 (53.4)	20 (9.7)
	B8. I volunteer to work for organizations involving Pili sustainability.	2 (1.0)	31 (15.0)	107 (51.9)	66 (32.0)

In the knowledge domain, most of the science teachers who responded to the OSISDeP strongly agreed that the SD of Pili supports different cultural values in the Bicol region (K5 = 79.6%), involves improving the people's understanding of Pili (K8 = 76.2%), helps women in the community earn money (K3 = 75.2%), and allots part of the Pili business's income for services that care for the environment (K7 = 75.2%). These results indicate that the science teachers believe that the SD of Pili contributes to people's understanding of the environmental, social, economic, and political aspects. Furthermore, most of the science teachers are highly knowledgeable on SD towards Pili as shown in Table 5.

Table 5

Level of Science Teachers' KAB towards SD during Application of the OSISDeP

Dimension	Level	Frequency	Percentage
Knowledge	Poor	0	0.0
	Moderate	17	8.3
	High	189	91.7
Attitudes	Poor	0	0.0
	Moderate	17	8.3
	High	189	91.7
Behaviors	Poor	128	62.1
	Moderate	69	33.5
	High	9	4.4

In the attitudes domain, as shown in Table 4, most science teachers feel happy when they see people who understand the importance of Pili in preserving the culture of the Bicol region (A1 =

90.3%) when they see people invest in Pili (A5 = 85.9%), and when the government encourages the use of renewable energy for Pili production (A7 = 83.5%). The most prevalent item for attitudes pertains to SD with relevance to the culture that is the same as the results obtained in the knowledge domain. These results indicate that the Pili is not only a plant that is significant for its environmental and economic purposes but also an essential element of the Bicol culture. Due to the geographic position and physical environment, the Philippines is one of the most disaster-prone nations in the world and the Bicol region is one of the locations commonly affected by natural disasters such as typhoons and floods (Mascariñas et al., 2013). Over time, the Pili tree has demonstrated its tenacity and adaptation to the irregular climatic condition of the Bicol area withstanding heavy typhoons and floods. As a result of these traits, the local community branded Pili as "the tree of hope," feeling that it plays a key role in their culture (Philippine Department of Agriculture, 2011). Moreover, responses of science teachers show a high level of attitudes toward SD of Pili as shown in Table 5.

In the behaviors domain in Table 4, most of the science teachers disagreed that they attend seminars on SD of Pili, talk about how Pili could help lessen poverty, read studies on converting Pili wastes into useful materials, and coordinate with the government to plant Pili trees. These results indicate that although most of the science teachers have strongly agreed on the items in the knowledge and attitudes domains, they mostly disagreed that they manifest certain kinds of behaviors indicated in the OSISDeP. Furthermore, Table 5 shows that science teachers have a low level of behaviors toward the SD of Pili. These results are in parallel with the findings of Bamberg and Möser (2007) and Al-Naqbi and Alshannag (2018) that positive knowledge and attitudes are not indicators of favorable behaviors towards SD. Nevertheless, the researchers look further into the association of knowledge, attitudes, and behaviors among one another as shown in Table 6.

Table 6

Association of Knowledge, Attitudes, And Behaviors Using Pearson's Chi-Square Test of Independence

			Behaviors			
		Count	Poor	Moderate	High	*p*-value
Knowledge	Poor	0	0	0	0	.573
	Moderate	17	12	5	0	
	High	189	116 (61.38%)	64 (33.86%)	9 (4.76%)	
Attitudes	Poor	0	0	0	0	.665
	Moderate	17	11	6	0	
	High	189	117 (61.90%)	63 (33.33%)	9 (4.76%)	
			Attitudes			
Knowledge	Poor	0	0	0	0	.000
	Moderate	17	0	9	8	
	High	189	0 (0.0%)	8 (4.23%)	181 (95.77%)	

The results from the Pearson's Chi-square test revealed that science teachers with a high level of knowledge of the SD of Pili also had high levels of attitudes. On the other hand, science teachers with a high level of knowledge and attitudes exhibit low levels of behaviors. Additionally, Table 6 demonstrates a correlation between science teachers' knowledge and attitudes ($p < 0.05$). By contrast, the science teachers' behaviors are not associated with their knowledge and attitudes ($p > 0.05$). These findings explain why, despite their high levels of knowledge and attitudes, science teachers exhibit low levels of behaviors toward the SD of Pili. This supports the argument made by Bamberg and Möser (2007), Al-Naqbi and Alshannag (2018), and Borges (2019) that, although knowledge and attitudes are important, they are insufficient to elicit positive behaviors. As a result, teacher development efforts relevant to SD should not only concentrate on improving their knowledge and attitudes but also on improving their observable actions. Pedagogies that have been proven through time, such as Problem-Based Learning (Funa & Prudente, 2021; Hung, 2019), may be utilized to help students take part in solving real-world problems, hence increasing their observable behaviors toward

SD. The results and findings show that it is critical to engage in activities that let secondary science teachers directly demonstrate their support for SD.

Discussion and Further Developments

The study responded to the need for a short, quick, convenient, and accessible self-assessment evaluation tool that can be used by other researchers to comprehensively understand and measure the teachers' KAB towards SD. The results of confirmatory factor analysis revealed that the placement of the items for each factor is valid: Knowledge (items 1-8), Attitudes (items 9-16), and Behaviors (items 17-24). The inter-rater agreement among experts shows perfect scores for both the content and the face value. Further, the internal consistency among items was reliable for each factor and the overall instrument as well. These results mean that the OSISDeP is valid, reliable, and can accurately measure the high school science teachers' KAB toward the SD, focused on Pili (*Canarium ovatum*).

The development and validation of OSISDeP is a part of a bigger project that aims to integrate the SD of Pili in education and engage the youth in Pili sustainability activities. It adds to the existing tools to empirically measure and comprehensively understand SD. The use of this tool may reveal vital information on the secondary science teachers' KAB toward the SD of Pili. This information is important as they serve as baseline data for planning and conducting training, seminars, and workshops on SD; integrating and promoting Pili to learning and teaching processes; and contextualizing curricula, programs, and instructional materials for Philippine culture and Filipino learners.

The instrument could be adopted or improved by the Pili Governing Board of the region and other researchers in future studies. The concise, amplified, and easy-to-understand features of the instrument highlight its adaptability and usability for Bicolano Pili industry researchers. Furthermore, the instrument's contextualized theme ensures better understanding among its target respondents which reinforces high validity and reliability.

The study is limited only to the respondents which are all high school science teachers from the Bicol region with an awareness of the Pili plant and products. It can be noted that restriction to the approaches is present because of the limited number of respondents involved in the study. Furthermore, the respondents' characteristics and numbers have reduced the generalizability of the results. Caution is advised when generalizing the results to other respondents with different characteristics and the SD of other products. However, the methodology and the results of this study could be used for future studies relevant to the KAB toward SD.

The study recommends that future studies would work on the validation of OSISDeP. For example, it can be administered to a different group (e.g., teachers in elementary and tertiary, teachers with other majors/specializations, students in different levels, and people in the community). Furthermore, it can be modified to assess the KAB in a different context by changing the term "Pili." For instance, item 2 "The sustainable development of Pili involves minimizing wastes" could be changed into "The sustainable development of Citrus fruits involves minimizing wastes." This would allow other researchers to use the OSISDeP for sustainable development of other materials or products, locally and abroad, provided that they do additional validity and reliability tests. Additionally, it is recommended that the results and findings of this study be used to facilitate relevant intercultural and cross-cultural research studies. More research is needed to investigate and explore other factors involved in this instrument such as the four interacting complex systems of SD and the four dimensions of ESD, among others.

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References

Al-Naqbi, A. K., & Alshannag, Q. (2018). The status of education for sustainable development and sustainability KAB of UAE university students. *International Journal of Sustainability in Higher Education, 19*(3), 566-588. doi:10.1108/ijshe-06-2017-0091

Amézaga, T. R., Camarena, J. L., Figueroa, R. C., & Realivazquez, K. A. (2021). Measuring sustainable development knowledge, attitudes, and behaviors: Evidence from university students in Mexico. *Environment, Development, and Sustainability*. doi:10.1007/s10668-021-01467-0

Amran, A., Perkasa, M., Satriawan, M., Jasin, I., & Irwansyah, M. (2019). Assessing students' 21st-century attitude and environmental awareness: Promoting education for sustainable development through science education. *Journal of Physics: Conference Series, 1157*(2). doi:10.1088/1742-6596/1157/2/022025

Asparouhov, T., & Muthén, B. (2018). *SRMR in Mplus*. http://www. statmodel. com/download/SRMR2. pdf.

Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology, 27*(1), 14–25. doi:10.1016/j.jenvp.2006.12.002

Barloa, E. P., Lapie, L. P., & de la Cruz, C. P. P. (2016). Knowledge, attitudes, and practices on solid waste management among undergraduate students in a Philippine state university. *Journal of Environment and Earth Science*, *6*(6), 146-153.

Bogner, K. & Landrock, U. (2016). Response biases in standardised surveys. *GESIS Survey Guidelines.* doiI:10.15465/gesis-sg_016

Borges, F. (2019). Knowledge, attitudes, and behaviours concerning sustainable development: A study among prospective elementary teachers. *Higher Education Studies, 9*(2), 22. doi:10.5539/hes.v9n2p22

Brundtland, G. H. (1987). What is sustainable development? *Our common future*, *8*(9).

Catelo, S. P., & Jimenez, S. D. (2016). An exploratory study of the economic potential of Philippine Pili pulp oil from waste pulp. *Journal of Economics, Management, and Agricultural Development, 2*(1).

Cebrián, G., Junyent, M., & Mulà, I. (2020). Competencies in education for sustainable development: Emerging teaching and research developments. *Sustainability*, *12*(2), 579. doi:10.3390/su12020579

Cebrián, G., Segalàs, J., & Hernández, A. (2019). Assessment of sustainability competencies: A literature review and future pathways for ESD research and practice. *Central European Review of Economics and Management*, *3*(3), 19-44. doi:10.29015/cerem.664

Çepni, S. (2021). How to Structure the Conceptual and Theoretical Framework of Projects, Thesis, and Research Articles?. *Journal of Science, Mathematics, Entrepreneurship and Technology Education, 4*(3),203-216. https://dergipark.org.tr/en/pub/fmgted/issue/62917/938803

Debrah, J. K., Vidal, D. G., & Dinis, M. A. P. (2021). Raising awareness on solid waste management through formal education for sustainability: A developing countries evidence review. *Recycling*, *6*(1), 6. doi:10.3390/recycling6010006

Dodge, Y. (2008). *The concise encyclopedia of statistics: With 247 tables*. New York, NY: Springer.

du Monde, M. (2011). The KAP survey model (knowledge, attitudes, and practices). *USAID SPRING*. https://www.spring-nutrition.org/publications/tool-summaries/kap-survey-model-knowledge-attitudes-and-practices

Fitzner, K. (2007). Reliability and validity a quick review. *The Diabetes Educator, 33*(5), 775-780. doi:10.1177/0145721707308172

Funa, A. A., & Prudente, M. S. (2021). Effectiveness of problem-based learning on secondary students' achievement in science: A meta-analysis. *International Journal of Instruction*, *14*(4), 69-84. doi:10.29333/iji.2021.1445a

Funa, A. A., & Ricafort, J. D. (2019). Validation of gamified instructional materials in Genetics for grade 12 STEM students. *International Journal of Sciences: Basic and Applied Research, 47*(2), 168-180.

Funa, A. A., & Talaue, F. T. (2021). Constructivist learning amid the COVID-19 pandemic: Investigating students' perceptions of biology self-learning biology modules. *International Journal of Learning, Teaching, and Educational Research, 20*(3). doi:10.26803/ijlter.20.3.15

Gallanosa, C. V. (2021). [Photograph of Pili (*Canarium ovatum*)].

Gusti, A. (2016). The relationship of knowledge, attitudes, and behavioral intentions of sustainable waste management on primary school students in the city of Padang, Indonesia. *International Journal of Applied Environmental Sciences, 11*(5), 1323–1332.

Hanifah, M., Mohmadisa, H., Yazid, S., Nasir, N., & Saiyidatina Balkhis, N. (2020). Transformation of Education for Sustainable Development through Low Carbon Schools Community Program. *Journal of Turkish Science Education, 17*(3), 429-442. doi:10.36681/tused.2020.37

Heeren, A. J., Singh, A. S., Zwickle, A., Koontz, T. M., Slagle, K. M., & McCreery, A. C. (2016). Is sustainability knowledge half the battle?: An examination of sustainability knowledge, attitudes, norms, and efficacy to understand sustainable behaviours. International Journal of Sustainability in Higher Education, 17(5), 613–632. doi:10. 1108/ijshe-02-2015-0014

Hooper, D., Coughlan, J., & Mullen, M. R. (2008). Structural equation modelling: Guidelines for determining model fit. *Electronic journal of business research methods*, *6*(1), pp53-60. https://core.ac.uk/download/pdf/297019805.pdf

Hung, W. (2019). Problem design in PBL. In Moallem, M., Hung, W., & Dabbagh, N. (Eds.), *The Wiley handbook of problem-based learning* (pp. 249-272). Wiley Blackwell.

Hunter, L. (2012). Challenging the reported disadvantages of e-questionnaires and addressing methodological issues of online data collection. *Nurse Researcher*, *20*(1), 11-20. doi:10.7748/nr2012.09.20.1.11.c9303

Mascariñas, A. M., Baas, S., Köksalan, N., Amano, L. O., Mieves, P. M., Binoya, C. S., Foronda, V., Dalida, L. U., Carbonel, M. R., Torre, E. R. dela, & Torrente, E. C. (2013). Mainstreaming disaster risk reduction into agriculture: A case study from Bicol Region, Philippines. *Environment and Natural Resources Management Series, Monitoring and Assessment-Food and Agriculture Organization of the United Nations, (20)*.

McKeown, R. (2002). Education for sustainable development tool kit. *Education for Sustainable Development Tool Kit*. www.esdtoolkit.org.

Michalos, A. C., Creech, H., Swayze, N., Maurine Kahlke, P., Buckler, C., & Rempel, K. (2012). Measuring knowledge, attitudes, and behaviours concerning sustainable development among tenth-grade students in Manitoba. *Social Indicators Research, 106*(2), 213–238. doi:10.1007/s11205-011-9809-6

Michalos, A. C., Kahlke, P. M., Rempel, K., Lounatvuori, A., Macdiarmid, A., Creech, H., & Buckler, C. (2017). Progress in measuring knowledge, attitudes, and behaviours concerning sustainable development among tenth-grade students in Manitoba. *Development of Quality of Life Theory and Its Instruments,* 301-336. doi:10.1007/978-3-319-51149-8_15

Michalos, A. C., Kahlke, P. M., Rempel, K., Lounatvuori, A., MacDiarmid, A., Creech, H., & Buckler, C. (2015). Progress in measuring knowledge, attitudes, and behaviours concerning sustainable development among tenth-grade students in Manitoba. Social Indicators Research, 123(2), 303–336. doi:10.1007/s11205-014-0752-1

Millena, C. G., & Sagum, R. S. (2018). Philippine Pili (Canarium ovatum, Engl.) varieties a source of essential minerals and trace elements in human nutrition. *Journal of Food Composition and Analysis, 69*, 53-61. doi:10.1016/j.jfca.2018.02.008

Montebon, D. R. T. (2018). Pre-service teachers' concept of sustainable development and its integration in science lessons. *Jurnal Pendidikan Humaniora*, *6*(1), 1-8.

Philippine Department of Agriculture (2011) *Pili Technoguide*. Phil-DA. http://bicol.da.gov.ph/attachments/article/28/Pili%20Technoguide.pdf

Randolph, J. J. (2008). Online kappa calculator [Computer software]. http://justus.randolph.name/kappa

Razali, N. M., & Wah, Y. B. (2011). Power comparisons of Shapiro-Wilk, Kolmogorov-Smirnov, Lilliefors, and Anderson-Darling tests. *Journal of statistical modeling and analytics*, *2*(1), 21-33.

Richey, R. C., & Klein, J. D. (2005). Developmental research methods: Creating knowledge from instructional design and development practice. *Journal of Computing in Higher Education, 16*(2), 23-38. doi:10.1007/bf02961473

Sachs, J. (2015). *The age of sustainable development*. New York: Columbia University Press.

Schrader, P. G., & Lawless, K. A. (2004). The knowledge, attitudes, & behaviors approach how to evaluate performance and learning in complex environments. *Performance Improvement, 43*(9), 8-15. doi:10.1002/pfi.4140430905

Snedecor, G.W., & Cochran, W. G. (1989) *Statistical methods*. 8th Edition, Iowa State University Press, Ames.

Sorsogon Pili Board (2018). *Status of Pili industry in Sorsogon and Bicol*. Province of Sorsogon Archives.

Sorsogon Pili Roadmap (2018). *Pili roadmap*. Sorsogon State College and Office of Sen. Chiz Escudero. Sorsogon City, Philippines. Province of Sorsogon.

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, *48*(6), 1273-1296. doi:10.1007/s11165-016-9602-2

Ugulu, I. (2015). Development and validation of an instrument for assessing attitudes of high school students about recycling. *Environmental Education Research, 21*(6), 916-942. doi:10.1080/13504622.2014.923381

United Nations Conference on Environment & Development (1992). *United Nations conference on environment and development.* UNCED 2019 Rio de Janeiro, Brazil. https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf

United Nations Educational, Scientific and Cultural Organization (2014). UNESCO roadmap for implementing the global action programme on education for sustainable development. United Nations Educational, Scientific and Cultural Organization.

United Nations Educational, Scientific and Cultural Organization (2018). *Issues and trends in education for sustainable development*. United Nations Educational, Scientific and Cultural Organization. https://en.unesco.org/sites/default/files/issues_0.pdf

Valencia, M. I. C. (2018). Introducing education for sustainable development (ESD) in the educational institutions in the Philippines. *Journal of Sustainable Development Education and Research*, *2*(1), 51-57. doi:10.17509/jsder.v2i1.12358

Waltner, E. M., Rieß, W., & Mischo, C. (2019). Development and validation of an instrument for measuring student sustainability competencies. *Sustainability, 11*(6), 1717. doi:10.3390/su11061717

World Commission on Environment and Development (1987). *Report of the world commission on environment and development: Our common future.* WCED 1987. http://www.un-documents.net/our-common-future.pdf

Yang, G., Lam, C. C., & Wong, N. Y. (2010). Developing an instrument for identifying secondary teachers' beliefs about education for sustainable development in China. *The Journal of Environmental Education*, *41*(4), 195-207. doi:10.1080/00958960903479795

Zyadin, A., Puhakka, A., Ahponen, P., & Pelkonen, P. (2014). Secondary school teachers' knowledge, perceptions, and attitudes toward renewable energy in Jordan. *Renewable Energy*, *62*, 341-348. doi:10.1016/j.renene.2013.07.033