Diversitas Journal
ISSN 2525-5215
Volume 9, Issue 4 (Oct./Dec. 2024) p. 1925 – 1943
https://diversitasjournal.com.br/diversitas_journal

Differential Treatment of Science, Technology, and Society Themes in the Philippine Junior High School Science Curriculum

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A B S T R A C T

Curriculum planners contend that the Science-Technology-Society (STS) Approach in Science instruction is one pedagogical practice leading to students' scientific literacy development - the overarching goal of science education. This study assessed the treatment of STS themes in the Junior High School (JHS) science curriculum, as reflected in textbooks and practiced by science teachers. Twelve textbooks (from two commercial publishers and the State Textbook Bureau) were analyzed for their treatment of 12 STS themes. STS-related key concepts, terms, and illustrations were the units of analysis. Meanwhile, the teachers' treatment was assessed through self - and student assessment. Results showed that, as a whole, the STS themes emphasized in the textbooks and by the science teachers were consistent. The two STS themes most emphasized are "Human Health and Diseases" and "Air Quality and the Atmosphere." Conversely, "Nuclear Reactors" and "War Technology" are the topics least covered. There was a differential treatment of the STS themes in the three textbooks regarding the STS-related key concepts, keywords, and illustrations. The same differential treatment was observed across the four grade levels. The curriculum implementers (*i.e.*, the science teachers) recommended proper treatments of the STS themes. Finally, a model was developed depicting the differential treatment of the STS themes in the junior high school curriculum.

RESUMO
Os planejadores curriculares afirmam que a Abordagem Ciência-Tecnologia-Sociedade (CTS) no ensino de Ciências é uma prática pedagógica que conduz ao desenvolvimento da literacia científica dos alunos - o objectivo global da educação científica. Este estudo avaliou o tratamento de temas CTS no currículo de ciências do Ensino Médio (JHS), refletido em livros didáticos e praticado por professores de ciências. Doze livros didáticos (de duas editoras comerciais e do State Textbook Bureau) foram analisados quanto ao tratamento de 12 temas CTS. Os principais conceitos, termos e ilustrações relacionados ao CTS foram as unidades de análise. Enquanto isso, o tratamento dos professores foi avaliado por meio de avaliação própria e dos alunos. Os resultados mostraram que, no seu conjunto, os temas CTS enfatizados nos livros didáticos e pelos professores de ciências eram consistentes. Os dois temas CTS mais enfatizados são "Saúde e Doenças Humanas" e "Qualidade do Ar e Atmosfera". Por outro lado, "Reatores Nucleares" e "Tecnologia de Guerra" são os temas menos abordados. Houve um tratamento diferenciado dos temas CTS nos três livros didáticos em relação aos principais conceitos, palavras-chave e ilustrações relacionados a CTS. O mesmo tratamento diferenciado foi observado nos quatro níveis de escolaridade. Os implementadores curriculares (ou seja, os professores de ciências) recomendaram tratamentos adequados dos temas CTS. Por fim, foi desenvolvido um modelo que retrata o tratamento diferenciado dos temas CTS no currículo do ensino fundamental.

RESUMEN
Los planificadores curriculares sostienen que el enfoque Ciencia-Tecnología-Sociedad (CTS) en la enseñanza de las ciencias es una práctica pedagógica que conduce al desarrollo de la alfabetización científica de los estudiantes: el objetivo general de la educación científica. Este estudio evaluó el tratamiento de los temas CTS en el plan de estudios de ciencias de la escuela secundaria (JHS), tal como se refleja en los libros de texto y lo practican los profesores de ciencias. Se analizaron doce libros de texto (de dos editoriales comerciales y de la Oficina Estatal de Libros de Texto) para determinar su tratamiento de 12 temas CTS. Las unidades de análisis fueron conceptos clave, términos e ilustraciones relacionados con CTS. Mientras tanto, el trato de los docentes se evaluó a través de la autoevaluación y la evaluación de los estudiantes. Los resultados mostraron que, en conjunto, los temas CTS enfatizados en los libros de texto y por los profesores de ciencias eran consistentes. Los dos temas CTS que más se destacan son "Salud y enfermedades humanas" y "Calidad del aire y atmósfera". Por el contrario, los "reactores nucleares" y la "tecnología de guerra" son los temas menos tratados. Hubo un tratamiento diferencial de los temas CTS en los tres libros de texto con respecto a los conceptos clave, palabras clave e ilustraciones relacionados con CTS. Se observó el mismo trato diferencial en los cuatro grados. Los implementadores del plan de estudios (es decir, los profesores de ciencias) recomendaron tratamientos adecuados de los temas CTS. Finalmente, se desarrolló un modelo que representa el tratamiento diferencial de los temas CTS en el plan de estudios de la escuela secundaria.

Article process:
Submitted: 08/25/2024
Approved: 11/13/2024
Published: 11/14/2024

Keywords:
science textbooks, science teachers, human health and diseases, air quality , atmosphere

Palavras – Chaves
Livros de ciências, Professores de ciências, Saúde humana e doenças, atmosfera

DOI: 10.48017/dj.v9i4.3132

Introduction

Scientific literacy has evolved to become the major goal of science education worldwide (Cakici, 2012; Fortus et al., 2022). This scientific literacy concept is one of the emerging categories of literacies referring to ability of a contemporary citizen to "appreciate the relevance of and draw upon scientific knowledge and practices in a broad range of personal and social issues" (Fortus et al., 2022, p. 4). Thus, a scientifically literate population is able to help democratic societies decide equitably and prudently on issues and concerns involving science (Snow & Wibner, 2016; Rudolph & Horibe, 2015).

Such scientific literacy goals has permeated the science curriculum reform efforts in many countries, including the Philippines. Together with technological and environmental literacy, science literacy has been set as a cornerstone in the science curriculum framework in the Philippines (Amirshokoohi, 2016; Curriculum Framework for Science, Philippine Department of Education [DepEd], 2016).

To achieve the scientific, environmental, and technological literacy goals for science education, the same science curriculum framework has identified and recommended some pedagogical approaches for teachers and educators. Among these recommended approaches are issue-based teaching, inquiry-based learning, and problem-based learning, and the science, technology, and society (STS) approach (DepEd Curriculum Framework for Science, 2016). All these approaches teach students to critically examine scientific issues from an analytical perspective through the STS approach. Such schemes allow learners to acquire, understand, and evaluate scientific knowledge (Autieri et al., 2016).

The STS approach investigates how social, political, and cultural values influence scientific research and technological innovation and how these, in turn, influence society. The STS approach aims to promote responsible citizenship in our technologically dominated era, (Waks, 1992).

A lot of STS-related issues confronting all citizens must be taught in schools. However, despite the promotion of the STS approach in the Philippine science education curriculum framework, the specific STS-related issues science teachers and educators should focus on are still wanting.

Some STS-related issues that can be incorporated in science lessons were identified in science education literature. For instance, Amirshokoohi (2016) identified some of the more common STS – related issues for science teachers to focus on. These issues are landfill overflows, excessive consumption, global warming, energy shortages, and nuclear waste disposal. Also, Trowbridge et al. (2000) earlier identified other STS-issues, including human health and diseases, air quality and atmosphere, population growth, species extinction, water resources, world hunger, and mineral resources depletion.

Given the crucial role of the STS approach in science education, there are some important questions that are worth asking. How is this approach carried out by curriculum implementers and teachers in the Philippine educational system? Are some STS themes better emphasized than others?" What factors led to differential treatment?

The teachers' implementation of the curriculum can be assessed by direct survey of the teachers themselves or the students they are currently teaching or those whom they have taught previously. Also, curriculum implementation by teachers can be indirectly assessed by examining the textbooks and references they are using. This is a valid claim because textbooks are popular teaching resource (Bansiong, 2019; Cakici, 2012; Chiapetta et al., 2006), and teachers structure and organize their lessons based on textbooks (Behnke, 2018; Stern & Roseman, 2004).

Unfortunately, studies involving curriculum implementation are not very popular in the Philippines. The authors of this paper have yet to see studies that specifically assessed how STS themes are treated in science curriculum materials and by science teachers. Hence, it is assumed that this paper is one of the few studies that addresses such an important research gap.

This study is thus conducted to provide insights into how STS themes are treated and emphasized in junior high school classes in the Philippines. Specifically, this study assessed the level of emphasis of the 12 STS themes in the junior high school curriculum in the Philippines in commercial and state-issued science textbooks. It also ascertained how science teachers emphasize the 12 STS themes as assessed by the teachers themselves and by their students.

This study could be very useful for instructional materials developers, as it will contribute to creating a model for developing STS issues-based learning resources, textbooks, and other learning guides.

Methodology

Research Design. This study employed both quantitative and qualitative approaches. The data analysis used specific quantitative document analysis and survey procedures.

Corpora. The textbooks analyzed in the study came from two popular commercial publishing companies in the Philippines. The other set was from the learner materials produced by the national textbook board. Textbook samples for grades seven to grades 10 in were analyzed, Thus, 12 textbooks were analyzed in total.

The commercial science textbooks were borrowed from a local private high school while the State-Issued Learning Materials were borrowed from the biggest public school in the province Details of the textbooks are shown in Table 1.

Table 1.

Title and Publisher Code of the Textbooks Analyzed in the Study

Textbook Code	Publisher
TB A	State Textbook Bureau
TB B	Commercial Publisher A
TB C	Commercial Publisher B

Procedures. The STS themes were lifted from Trowbridge and colleagues (2000) are shown in Table 2.

Google Lens and Google Docs were used to aid the researchers in counting keywords and concepts. The first application digitalized the printed material, making it easier to count by word count functions. In case the researchers did not agree on the classification of a key concept or keyword or whether or not a term is a keyword, consensus was reached by voting, and a simple majority rule was used. When in doubt, the researchers consulted their adviser.

The study's second objective is to determine how science teachers treat or prioritize the 12 STS themes in their science classes. Two hundred fifty-three (253) junior high school in-service science teachers from various schools across Luzon in the Philippines were asked to rank the 12 themes in order of priority, from 1 to 12, with one being the most emphasized and 12 the least emphasized. The ranks given were reversed scored by subtracting the rank given by 13. This means that a theme ranked one will score 12 points, while one ranked 12 will receive a score of one. The scores in each theme were added and then divided by the number of respondents. This means the higher the score on a STS theme, the more extensive its treatment. The teachers were likewise asked to explain their rankings.

Similarly, one hundred forty science education students (140) were asked to rank their former science teachers' treatment of the 12 STS themes retrospectively. The prospective science teachers were selected because they have a course in STS and are familiar with the concept and its themes. The ranks were then scored following the same procedure as the in-service science teachers.

The survey was conducted using online procedures. Permissions were sought to conduct the study, and the participants voluntarily participated in the survey. The online survey lasted for 31 days. To assist the teachers and students in ranking the 12 STS themes, they were asked to rate the most important STS themes first (i.e., 1,2,3), then the least important ones (i.e., 12,11,10,9). Finally, the middle possibilities (i.e., 5, 6, 7, 8) were completed from most to least significant.

Table 2.

Twelve STS Themes and Associated Key Concepts

STS Themes	Key Concepts
1. Air Quality and Atmosphere	Acid rain, CO2, Ozone depletion, Global warming
2. Energy shortages	Synthetic fuels, Solar power, Fossil fuels, Conservation, Oil production
3. Extinction of Plants and Animals	Reducing genetic diversity, In breeding, Genetic drift, Restricted gene flow, Small population size
4. Substances	Waste dumps, Toxic chemicals, Lead paints
5. Human Health and Diseases	Infectious and non-infectious disease, Stress, Diet and nutrition, Exercise, Mental health
6. Land use	Soil erosion, Reclamation, Urban development, Wildlife habitat loss, Deforestation, Desertification
7. Mineral resources	Nonfuel minerals, Metallic and non-metallic minerals, Mining, Technology, Low-grade deposits, Recycling, Reuse
8. Nuclear Reactors	Nuclear waste management, Breeder reactors, Cost of construction, Safety
9. Population Growth	World population, Immigration, Carrying capacity, Foresight capability
10. War Technology	Nerve gas, Nuclear development, Nuclear arms threat
11. Water Resources	Waste disposal, Estuaries, Supply, Distribution, Groundwater Contamination, Fertilizer contamination
12. World Hunger and Food Resources	Food production, Agriculture, Cropland conservation

Ethical Considerations. Participation in the study was completely voluntary. The concerned offices gave permission for the release of textbooks and the conduct of student questionnaires. Furthermore, respondents were asked for their consent and informed of the anonymity and confidentiality of the collected data.

Treatment of Data. For the first objective, data were summarized by frequency, percentages, and ranks and presented in tables. STS treatments per grade level, textbook publisher, or STS themes were associated using Spearman rho correlations and Chi-square test for independence. As for the second objective, the ranks of teachers and students were compared to determine significant differences in their responses. The Spearman rho correlation was used for this purpose, as the analysis concerned ranked data. The resulting r values were interpreted following Table 3.

Table 3.

Spearman Rho Correlation Interpretation

Spearman p	Correlation
≥0.70	Very Strong Relationship
0.40 – 0.69	Strong Relationship
0.30 – 0.39	Moderate Relationship
0.20 – 0.29	Work relationship
0.1 – 1.19	No or Negligible Relationship

Note: Descriptor applies to both positive and negative.
(Adapted from Dancey and Reidy, 2004)

RESULTS AND DISCUSSION

Presented in this section are the STS themes and the extent of treatment of these themes in the three textbooks. The science teachers' extent of treatment of these STS themes are also presented here. Finally, a model that encapsulates the differential treatment of the STS themes in the textbooks and by the teachers is likewise contained in this section.

Comparison of the number of STS themes covered in the three textbooks per grade level in the three textbooks

Overall, the greatest number of STS themes (about nine themes) were covered in the Grade 9 textbooks. This differs from the Curriculum Guide, which covered most of the STS themes in Grade 7.

Table 4.

Comparison of the Number of STS Themes Covered in the Three Textbooks per Grade Level.

Grade Level	*TB A*	*TB B*	*TB C*	*MEAN*
Grade 7	*9*	*8*	*7*	*8.00*
Grade 8	*5*	*4*	*9*	*6.00*
Grade 9	*10*	*10*	*8*	*9.33*
Grade 10	*5*	*9*	*7*	*7.00*
MEAN	*7.00*	*7.75*	*7.75*	

In particular, many of these STS themes are found in the SLM and the CTA. Meanwhile, the fewest STS themes are contained in the textbooks for Grade 8, where only half of the 12 identified themes are included. Based on the total and means per grade level, the distribution of the STS themes in the four grade levels needs to be balanced. Such imbalance can undermine the learners' understanding and acquisition of all the 12 themes.

The two commercial textbooks had about eight themes, and the state-issued learning material had seven. Relatively fewer themes were noted in TB C for Grade 8 and TB A for Grades 8 and 10. Finally, of the three textbooks, the distribution of the STS themes among the Grade levels is most "balanced" in TB C.

Analysis of the Presence of 12 STS-related Concepts, Keywords, and Illustrations in the Three Textbooks.

Key Concepts. The two STS themes with the most associated key concepts are Air Quality and Human Health and Diseases.

Table 5.

Comparison of the three textbooks as to the number of key concepts associated per theme

STS Themes	TB A	TB B	TB C	TOTAL	MEAN	RANK
1. Air quality and Atmosphere	9	11	13	33	16.5	1
2. Energy shortages	6	7	6	19	9.5	4
3. Extinction of Plants and Animals	5	6	5	16	8	5
4. Substances	4	1	1	6	3	10
5. Human Health and Diseases	8	7	7	22	11	2
6. Land use	5	8	2	15	7.5	6
7. Mineral resources	7	1	2	10	5	9
8. Nuclear Reactors	0	3	1	4	2	11
9. Population Growth	3	5	4	12	6	8
10. War Technology	0	0	2	2	1	12
11. Water Resources	5	5	10	20	10	3
12. World Hunger and Food Resources	5	5	4	14	7	7
TOTAL	57	59	57			
Rank	2.5	1	2.5			

In comparison, the two themes with the least associated key concepts are Nuclear Reactors and War Technology. These results suggest that textbook writers see issues of air quality and human health and diseases as a serious matter that needs to be addressed. On the other hand, war technology and nuclear reactors are topics of less concern and, therefore, may be ignored when time is insufficient. Not a single concept about War Technology and Nuclear Reactors is present in TB A and in TB B. This is the case in the two textbooks since the two topics are not explicitly included as competencies in the national standards.

TB C particularly abundantly contains key concepts associated with air quality and the atmosphere, although key concepts under this theme top the two other textbooks.

When the textbooks are compared on how they treat the 12 STS themes regarding the number of key concepts, the Friedman rank test revealed no significant differences ($p = .673$). These results indicate that the three textbooks cover the 12 STS themes quite similarly*, i.e.*, the three textbooks tend to put more or less emphasis on the same themes. The writers of the three textbooks are consistent on what STS issues are more pressing and which are not. Also, since the three textbooks usually follow the curricular mandates, they are more or less the same in content.

The Chi-square test revealed a significant difference when the number of STS-related concepts is compared according to grade level ($\chi^2 = 13.77$, $p = .032$). The three textbooks intended for Grade 7 and Grade 9 have more STS-related key concepts. Meanwhile, the Grade 8 textbooks have the lowest number of STS-related key concepts.

Table 6.

Comparison of the number of STS-related Key Concepts per Grade Level

Grade Level	TB A	TB B	TB C	TOTAL	RANK
Grade 7	23	13	15	51	1
Grade 8	8	7	13	28	4
Grade 9	19	19	12	50	2
Grade 10	7	20	17	44	3
Consistent?	A	B	C		

The Chi-square test does not indicate that the emphasis on the STS-related key concepts is consistent across the three textbooks. All three combinations had no significant associations ($p = .60$ for all combinations). Therefore, the three textbooks distribute the key concepts to the grade levels differently.

TB C is most equally distributed when comparing the textbooks' distribution of STS-related key concepts in the four grade levels. The goodness of fit values indicates no significant difference (p = .874). There was a fair distribution of STS themes only for Grade 7, Grade 9, and Grade 10 for TB B. As for TB A, there was unequal distribution of STS key concepts in the four grade levels (p = 0.002). This unequal distribution of key concepts across the four grade levels in the state-issued learning materials may shortchange learners in one grade level and overburden them in another. Such unequal distribution suggests that textbook writers should consider revising their materials to balance STS information across grade levels better.

Keywords. The number of keywords associated with an STS-related key concept indicates the depth of explanation and emphasis in textbooks. Based on the analysis, Human health and diseases, air quality and atmosphere, and water resources contain the most keywords when all three textbooks are combined (Table 7). Such a result is unsurprising because these are the same themes with the most key concepts. Naturally, the more key concepts, the more keywords are used to explain them.

Table 7.
Comparison of the three textbooks as to the number of keywords associated with each theme

STS Theme	TB A	TB B	TB C	TOTAL	MEAN	RANK
1. Air quality and atmosphere	1941	1021	2516	5478	2739	2
2. Energy shortages	922	810	1446	3178	1589	4
3.Extinction of plants and animals	613	1091	1080	2784	1392	5
4. Substances	306	148	147	601	300.5	11
5. Human health and diseases	3108	2591	4499	10198	5099	1
6. Land use	276	385	548	1209	604.5	8
7. Mineral resources	849	107	1186	2142	1071	7
8. Nuclear reactors	0	557	166	723	361.5	10
9. Population growth	351	476	416	1243	471.5	9
10. War technology	0	0	166	166	258.5	12
11. Water resources	871	153	2325	3349	1674.5	3
12. World hunger and food resources	694	565	940	2199	1099.5	6
TOTAL	9982	7904	15435	33321		
Rank	3	2	1			

With the number of keywords considered, the Human health and diseases theme appeared to be the most extensively presented or explained in all three textbooks. This means that the writers put a premium on staying healthy and disease-free. With a healthy body, one can move and act towards self-improvement and live fully.

The result deviated little from the result on the number of key concepts. While there are more key concepts related to Air Quality and Atmosphere, this theme was explained using fewer keywords than Human Health and Diseases. Such a result may indicate that the topics of Human Health and Diseases were better elaborated on or explained than those of Air Quality and Atmosphere.

Meanwhile, the themes with the highest number of keywords are those under war technology, substances, and nuclear reactors. This implies that textbook writers should include these equally important topics in their materials.

When comparing the three textbooks in the depth or comprehensiveness of their presentation of the 12 STS themes, Spearman rho correlation revealed a significant association between TB A and TB B ($r_s = 0.897$, $p = .000$) but not in the other two combinations ($p > .05$). This means that only TB A and TB B have nearly similar treatments of the 12 themes.

The same trend surfaced for the key concepts when the number of STS-related keywords in the three textbooks was compared according to grade level. Chi-square statistics reveal a significant difference in the keywords used compared to grade level ($\chi^2 = 6558.6$, $p < .00001$). This result implies that there are more extensive discussions of STS themes in some grade levels but not with others. STS-related keywords are abundant in the Grade 7 textbooks, followed by Grade 9. The fewest keywords are in the Grade 8 textbooks.

Table 8.

Comparison of the number of STS-related Keywords per Grade Level

Grade Level	TB A	TB B	TB C	TOTAL	RANK
Grade 7	3640	1321	13554	18515	1
Grade 8	2072	254	2530	2784	4
Grade 9	2907	2879	4932	10718	2
Grade 10	1363	3540	4419	9322	3

To determine whether or not the three textbooks expound on the STS themes similarly across grade levels, the number of keywords per grade level in each textbook was subjected to Spearman rho correlation. Results revealed no significant association ($p = 0.6, 0.2, 0.8$). This means that the textbooks expound on the STS-related concepts differently in the different

grade levels. SLM, for instance, emphasized STS topics most in Grade 7 and least in Grade 10, while TB B emphasizes STS topics mostly in Grade 10 but not much in Grade 8. This means that textbooks must first be thoroughly evaluated before they are acquired.

*Illustrations***.** Illustrations were considered to assess how the textbooks present the STS themes in visual forms. The accompanying pictures or diagrams in textbooks are often attention-grabbing and provide an excellent avenue to supplement what is presented as texts. The number of illustrations about the 12 STS themes is shown in Table 9.

Table 9.

Comparison of the three textbooks as to the number of illustrations associated with each theme

STS Theme	TB A	TB B	TB C	TOTAL	MEAN	RANK
1. Air quality and Atmosphere	26	28	28	82	41	2
2. Energy shortages	7	27	20	54	27	3
3. Extinction of Plants and Animals	4	19	18	41	20.5	5
4. Substances	0	0	4	4	2	10
5. Human Health and Diseases	51	37	32	120	60	1
6. Land use	13	11	11	35	17.5	7
7. Mineral resources	5	0	5	10	5	9
8. Nuclear reactors	0	2	0	2	1	11
9. Population growth	4	6	6	16	8	8
10. War technology	0	0	1	1	0.5	12
11. Water resources	7	9	29	45	22.5	4
12. World hunger and food resources	15	11	14	40	20	6
TOTAL	132	150	168			
Rank	3	2	1			

The same themes top the number of illustrations - Human health and diseases, and Air Quality and Atmosphere. This time, there are lots of illustrations on energy shortages. These topics are the common issues besetting our present world, and it is natural to give them a premium in discussing STS.

On the other hand, two STS themes are depicted least in pictures: war technology (1) and nuclear reactors (2). This result is expected because the curriculum guide does not mandate these topics. Moreover, as the previous results have shown, war technology and nuclear reactors are the concepts least represented in the three textbooks.

Comparing the number of illustrations in the textbooks, TB C has the most, followed by TB B. Except for nuclear reactors, there is an illustration for all STS themes in TB C. Also, comparing how the three textbooks visually present the 12 STS themes, Spearman rho correlation was done. Results showed a significant association in all three combinations, with p values ranging from p = 0.000 (TB B vs TB C) to p = 0.002 (TB A vs TB B). Such statistical results show that the textbooks either emphasize or skip the same themes in their illustrations.

The number of STS-related illustrations in the three textbooks per grade level varied slightly based on key concepts and keyword analysis. Regarding illustrations, the Grade 9 textbooks have more STS-themed illustrations than the Grade 7 material.

Like in the previous results, there are significant differences in the number of STS-related illustrations when compared by grade levels (χ^2 = 5.9124; p = .000). The Grade 8 textbooks have the fewest illustrations, particularly in TB B.

Table 10.

Comparison of the number of STS-related Illustrations per Grade Level

Grade Level	TB A	TB B	TB C	TOTAL	RANK
Grade 7	31	53	38	122	2
Grade 8	28	12	42	54	4
Grade 9	47	51	50	148	1
Grade 10	26	34	58	118	3

Moreover, the illustrations are well-distributed across grade levels in TB C and TB A. In TB B, however, an imbalance is clear, especially in the Grade 8 textbooks. Also, the distribution of the illustrations across the grade levels is different in the three textbooks. This resulted from the Spearman rho correlation, which showed no significant associations ($p > .05$) in the number of illustrations in the textbooks among the grade levels. This means some textbooks have more STS-themed illustrations in one grade level, say Grade 10, and fewest in Grade 7, while others have more illustrations in Grade 7 and least in Grade 8.

Summary of the Treatment of the Three Textbooks of the STS Themes According to the Number of Key Concepts, Keywords, and related Illustrations

Table 11 presents the ranks of the treatments of STS themes in the three textbooks according to key concepts, keywords, and illustrations. The researchers assume that the lower the total ranks, the greater the level of treatment or emphasis of the theme.

Considering the number of key concepts, keywords, and illustrations, textbooks extensively cover two themes: health and diseases, air quality, and the environment. Water resources and Energy Shortages are also extensively covered. The STS themes least emphasized in the three popular textbooks and learner material are Substances (Toxic wastes, etc.), Nuclear reactors, and War technology.

Table 11.

Combined Ranks of the Treatment of the Three Textbooks of the 12 STS Themes According to Key Concepts (KC), Keywords (KW) and Illustrations (illus).

STS Theme	KC	KW	Illus	TOTAL	RANK	SCORED RANK
Human Health and Diseases	2	1	1	4	1	12 (VE)
Air Quality and Atmosphere	1	2	2	5	2	11 (VE)
Water Resources	3	3	4	10	3	10 (E)
Energy shortages	4	4	3	11	4	9 (E)
Extinction of Plants and Animals	5	5	5	15	5	8 (ME)
World Hunger and Food Resources	7	6	6	19	6	7 (ME)
Land use	6	8	7	21	7	6 (ME)
Mineral Resources	9	7	9	25	8.5	4.5 (ME)
Population Growth	8	9	8	25	8.5	4.5 (ME)
Substances	10	11	10	31	10	3 (SE)
Nuclear Reactors	11	10	11	32	11	2 (NE)
War Technology	12	12	12	36	12	1 (NE)

These results surfaced because the three least emphasized topics are also taken in other subject areas, such as health education (in the case of substances) or Social Studies (in the case of War technology). As for the more extensively presented topics, the writers may already be

very familiar with the concepts as they are trendy topics in academic conversations and the media. Also, the topics are relevant in the present world and extremely necessary for individual development and survival.

The above results can be corroborated with the study of Fadhi (2000) which showed that “Air Quality and Atmosphere”, “Energy shortages”, and “Water Resources” are the dominant themes among American Earth Science textbooks. There were no other published related studies except for that of a more recent study on undergraduate introductory science textbooks. These materials were analyzed for their coverage of two STS themes – climate change and energy technologies (Yoho & Rittman, 2018). Their results indicate that the textbook allotted about 4% of their pages to the two themes, and that there is a large variation among individual textbooks. There was likewise some discipline-based variations on the coverage of the two themes.

Science Teachers' Treatment of the 12 STS Themes.

Their ranking weighs the science teachers' treatment of STS themes in terms of how they emphasize or treat them in their classes. Also, pre-service science teachers were asked to recall their JHS teachers and assess how these teachers emphasized the 12 STS themes. They were asked to rank their teachers' degrees of treatment or emphasis. The means of the ranks given per theme were obtained. The lowest values in the mean of ranks were re-ranked as the first, the second lowest, ranked two, and so on. Table 12 shows the results of the rankings of teachers and students.

Table 12 shows that the teachers' and students' ranks agreed on the two most and least emphasized STS themes in science classes. Such results support those of the textbook analysis procedures emphasized in the previous sections. Teachers and textbook writers, who are primarily teachers themselves, agree that STS themes are important and thus need to be emphasized in science classes.

To determine whether the students and teachers agree on the magnitude by which STS themes are emphasized in actual classes, the Spearman rho correlation was employed. An rs value of 0.601 was obtained, with a p-value of .043. The teacher's and students' ranking of STS themes has a strong correlation, which implies that their ranks are quite similar.

In their ranks, the teachers claim that their emphasis on STS themes was based on "the issues that need attention" (Male, ST2) and on the "most relevant needs of people in order to improve their living" (Female, ST6). These statements prove the basis on which the STS theme emphasizes the pressing issues affecting survival and development. Aside from the topic's urgency, one respondent added "magnitude of the issue, and the level by which the learners can contribute to the solutions of the problems" (Male, ST16).

Table 12.

Science teachers' and students' ranking of teachers treatment of the STS themes

	Teachers		Students	
STS Themes	Mean of Ranks	**Final Rank**	Mean of Ranks	**Final Rank**
1. Air Quality	3.85	**2**	3.38	**1**
2. Energy Shortages	5.55	**6**	5.58	**5**
3. Extinction	5.64	**8**	5.98	**6**
4. Substances	5.87	**9**	5.48	**3**
5. Human Health and Diseases	3.21	**1**	4.80	**2**
6. Land Use	5.58	**7**	5.53	**4**
7. Mineral Resources	7.89	**10**	7.00	**9**
8. Nuclear Reaction	8.60	**11**	9.33	**11**
9. population Growth	5.17	**5**	6.65	**8**
10. War Technology	9.70	**12**	10.58	**12**
11. Water Resources	4.26	**3.5**	6.40	**7**
12. World Hunger	4.26	**3.5**	7.33	**10**

According to a teacher respondent: "Health is the number one priority because we live our life once. When health is wasted, it is difficult to regain it" (Female, ST42). Another teacher respondent confirmed the claim: "Human lives are the most important of all, so there should be a priority in programs related to human health and disease" (Female, ST19). Finally, a male teacher respondent (ST9) admitted that his ranking was affected by his experiences during this time of health crisis, the COVID-19 pandemic, which made people realize that health is indeed wealth.

According to Ackay and Yager (2010), the STS approach lets the students ask questions creatively and conceptualize the consequences of specific corrective actions. This is consistent with what the teachers suggested in this study. They argue that allowing STS-integrated classrooms will make students realize that their actions contribute to solving the capacity they have, so chances of making a solution to mitigate, prevent, and/or address these STS issues concerning society will be possible.

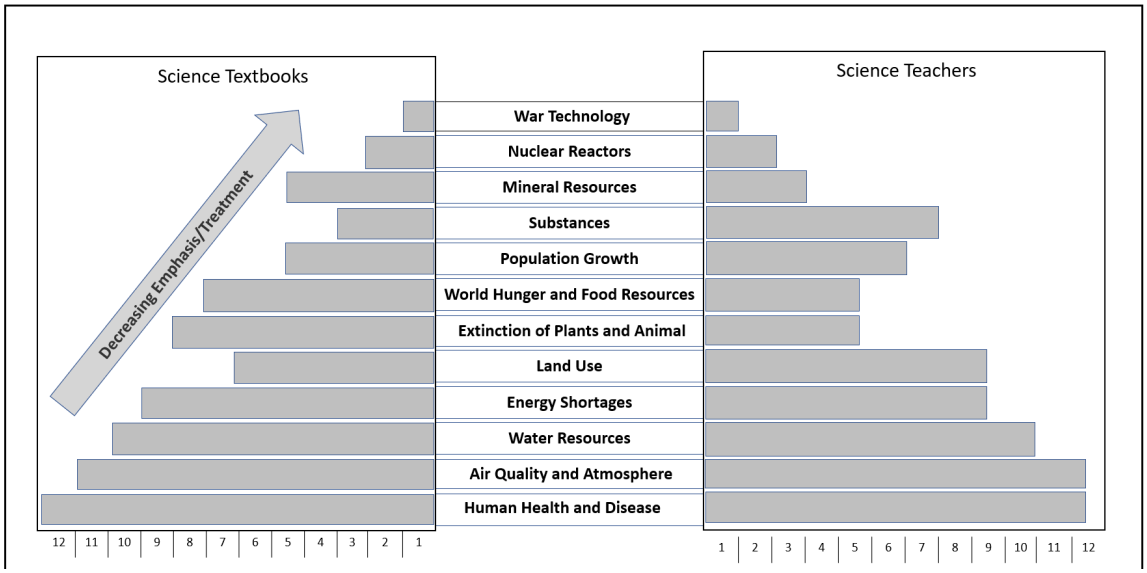
A similar study in Yemen conducted by Mai et al. (2012) asked teachers and students to rank a slightly modified list of STS themes. Teachers and the students ranked STS themes; the top-ranked issues that clearly relate to basic human needs (Health, Water, Air) and one of the most essential things in daily use (Energy Shortages). This is similarly demonstrated in the

ranking of the teachers conducted in this study. The slight difference is the addition of "Substances" as the students in the Philippines rank third, while “Energy Shortages” rank fifth and sixth for the teachers and the students, respectively.

Based on the above results, the researchers are proposing a model that can be used to show how STS themes are treated in the junior high school curriculum in the Philippines. The model is shown in Figure 1. The model above depicts the differential treatment of STS themes in science textbooks and teachers. It arranges the STS themes from the most emphasized (base) to the least emphasized (apex).

Figure 1.

The differential treatment of Science-Technology-and Society Themes in the Junior High School Science Curriculum in the Philippines



Based on the shape of the rectangles, there is a slight disagreement between teachers and textbooks in their treatment of the 12 themes. However, this disagreement needs to be bigger to be considered significant. Using Spearman rho correlation, the ranks have a positive, significant association (rs = 0.838, p = 0.000). This means that the ranks are essentially the same.

Conclusions

There are lots of STS themes that all citizens encounter and, therefore, need to be introduced in their early years, especially in schools. Very little research assesses the treatment of the STS approach in the junior science education curriculum in the Philippines. This is despite its mandate in the science curriculum framework. This study is one of the first studies in the country to explore the treatment and emphasis of STS themes in the junior high school

curriculum. Two popular commercial science textbooks and state-mandated learning material were analyzed for the presence of the STS themes. The results were triangulated with a survey on teacher practices. Both science teachers and students were surveyed for the purpose.

Some themes are absent in the curriculum guide, but they are treated superficially in some textbooks. There are differential treatments of the 12 themes, with pressing, urgent, and personal issues being more emphasized than those perceived to be more remote. There are likewise differential treatments of the STS themes by the three textbooks across grade levels. Teachers and students agree on the topics emphasized and not emphasized in classrooms. Finally, the STS themes emphasized in textbooks coincide with those discussed by the teachers more thoroughly.

Recommendations

Based on the conclusions drawn from the study's results, the researchers recommended that textbook writers consider addressing the issues on some STS themes not included in textbooks. This recommendation goes to science teachers as well. Also, because of the differential treatment of STS themes in the textbooks, the teacher may consider using more than one textbook in their science teaching to provide a more comprehensive discussion on STS. Further, science teachers may leverage their standing to emphasize STS issues that are not covered much in textbooks by consulting other sources to attain relevant knowledge.

Considering the limitations of this study, a follow-up study may be conducted to assess the treatment of STS in textbooks for elementary or senior high school students under the STEM strand.

Acknowledgements

The authors hereby acknowledge the institutions who lent copies of the textbooks evaluated in this study. Also, same acknowledgement goes to the science teachers and the students who responded to the survey instrument.

Declaration of Conflict of Interest

All authors declare that they have no conflict of interest in this study.

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