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SECONDARY TEACHERS' AND STUDENTS' PERCEPTIONS OF DISTANCE EDUCATION IN SCIENCE: FOCUS ON LEARNER-CENTERED, ACTION-ORIENTED, AND TRANSFORMATIVE LEARNING

Aaron A. Funa[a, b, c*], Renz Alvin E. Gabay[a], Kathy Lorraine Esdicul[a, d], Maricar S. Prudente[a, c]

[a]Department of Science Education, De La Salle University, Manila, Philippines
[b]Sorsogon State University, Sorsogon, Philippines
[c]Member, Governmental, Educational and International Policies Division, National Research Council of the Philippines, Manila, Philippines
[d]Catanduanes State University, Catanduanes, Philippines
[*]Corresponding author: Email: funaaaronaytona@gmail.com

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Abstract

The shift from conventional, face-to-face classroom teaching to distance education is a complex process that brings various challenges. To better understand the impact of this transition, the researchers examined the perceptions of secondary science teachers (n = 42) and students (n = 137). Specifically, the study focused on evaluating learner-centered, action-oriented, and transformative learning – referred to as LCAOT learning – in science distance education. The researchers developed a 26-item, 4-point Likert scale questionnaire that was distributed online to the target respondents. Additionally, the researchers interviewed teachers and students and analyzed various documents, such as self-learning modules and learners' activity sheets, to triangulate the survey data. The findings revealed that the principles of LCAOT learning were apparent in science distance education and exemplified through tools such as the Know, Want to Know, and Learned charts and personal journals. The study also revealed that teachers and students faced challenges during the transition to distance education, including inadequate equipment and poor internet connectivity. However, they responded to these challenges by using various means of communication, collaborating with peers, and exploring new roles and identities. The researchers recommend using the developed instrument and continuing to evaluate the effectiveness of teaching strategies employed in distance education in science, as well as further studies on the impact of LCAOT learning on students' academic achievement.

Keywords: Distance education; Education for sustainable development; Modular distance learning; Online distance learning; Science education.

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1. INTRODUCTION

Distance education has become prevalent due to unprecedented events that have caused drastic changes to the conventional classroom setting. For instance, the measures implemented to mitigate and control the spread of COVID-19 infection, such as social distancing, self-isolation, and quarantine protocols, have challenged the traditional human interaction process of the global education system, leading to the adoption of distance and online education (Cuaton, 2020; Daniel, 2020; Pokhrel & Chhetri, 2021). Aside from the prevention towards the COVID-19 infection, distance education also offers convenience and flexibility (Funa et al., 2023). However, despite the benefits of distance education, teachers and students experienced problems during this transition such as limited time, inadequate materials for laboratory activities, reduced collaborative activities, and slow internet connections (Adnan & Anwar, 2020; Funa & Talaue, 2021; Tria, 2020; Williamson et al., 2020). Therefore, teachers have found various adaptive interventions to conduct their lessons and achieve effective and efficient learning among students (Funa & Talaue, 2021).

Rieckmann (2018) defined learner-centered, action-oriented, transformative (LCAOT) learning as a pedagogy that incorporates real-world collaborative initiatives (e.g., immersion projects and campaigns), vision-building exercises (e.g., future creating workshops), complex system analysis (e.g., community-based research and case studies), and critical and reflective thinking (e.g., fishbowl discussions and reflective journals). This learning approach can be further understood by defining its three major components. *Learner-centered pedagogy* pertains to teaching and learning processes that maximize student autonomy in learning, participation in knowledge construction, and the capacity to freely express ideas and to reflect on their own decisions and actions (Doyle, 2011; Rieckmann, 2018; Weimer, 2013). *Action-oriented pedagogy* pertains to student actions and reflections on their personal real-world experiences gained by community services, internships, immersions, and other field exposure activities (Rieckmann, 2018). It may be accomplished by direct experiences, observations, reflections, the formation of abstract concepts, and the application of information, skills, and practices in novel and unfamiliar circumstances (Kolb, 1984; Morris, 2020). *Transformative pedagogy* pertains to students' abilities to intelligently evaluate and modify their views and actions to better respond to a variety of circumstances (Slavich & Zimbardo, 2012) and to challenge the status quo, cope with disruptive thinking, and synthesize earlier ideas and current experiences to create new knowledge (Lotz-Sisitka et al., 2015; Rieckmann, 2018).

The United Nations Educational, Scientific, and Cultural Organization (UNESCO) recommends LCAOT learning, recognizing it as a key pedagogical approach in implementing education for sustainable development, which is considered significant in achieving worldwide quality education (UNESCO, 2017, 2018, 2020). Pedagogies that involve LCAOT learning, such as problem-based learning, have historically been found effective in improving student performance and achievements in science courses (Funa & Prudente, 2021; Hannum et al., 2008). As a result, the Department of Education (DepEd) in the Philippines fosters teaching and learning processes that promote LCAOT principles, such as inquiry-based, problem-based, constructivist, and reflective learning, among others

(DepEd, 2016). Along with these guidelines, the DepEd employs measurements to monitor and evaluate education amid unprecedented times (DepEd, 2020a, 2020b).

The DepEd responded to the pandemic by issuing guidelines for distance education (DepEd, 2021). These guidelines provide various strategies for delivering education through synchronous or asynchronous modalities, including online, radio, and television. To further support teachers and learners during the pandemic, the DepEd implemented policies such as alternative work arrangements, flexible working hours, and mental health and psychosocial support (DepEd, 2020b; Funa et al., 2023). One of the significant initiatives of the DepEd is the development of self-learning modules in print and digitized forms that are delivered through a modular distance learning approach (Funa & Talaue, 2021). Additionally, the Commission on Higher Education (CHED) released guidelines for higher education institutions to implement flexible learning arrangements during the pandemic, including online learning, blended learning, and flexible learning (CHED, 2020). These policies and guidelines aim to ensure the continuity of teaching and learning while prioritizing the health and safety of learners, teachers, and staff.

In light of these challenges, it is essential to revisit the use and implementation of LCAOT pedagogy in education, primarily as education transitions from one mode to another in response to various situations and challenges. The transition from face-to-face to distance education has resulted in several issues, including fewer activities involving student interaction, collaboration, and group work, all of which are important elements in implementing LCAOT learning and teaching processes (Funa & Talaue, 2021). Further, this present study evaluates the use of LCAOT learning in a distance education setting, as recommended by UNESCO. In this context, the present study examines the perceptions of teachers and students regarding adaptive interventions using LCAOT learning in science distance education at the secondary level. The researchers explore how teachers and students managed the challenges encountered during the transition from face-to-face to distance education. The findings of this study may serve as a guide for educators who face similar unprecedented events that interfere with traditional education.

Investigating the state of LCAOT learning through the lens of teachers and students offers an opportunity for teachers themselves and curriculum designers to gain insights, cope with digital and technological advances, and achieve quality education despite shifting educational demands due to various circumstances. This study examines LCAOT learning in distance education, focusing on secondary science courses. The researchers investigated the perceptions of teachers and students concerning three significant components of LCAOT learning: learner-centeredness, action-orientation, and transformative learning. They aimed to understand the context of teacher and student engagement and adaptability to various challenges as in-person classes shifted to distance education.

2. METHODOLOGY

2.1. Research design

For this study, the researchers employed a descriptive cross-sectional survey design to collect the perceptions of LCAOT pedagogy from teachers and students during the transition from traditional in-person classrooms to distance education. A *cross-sectional survey design* is a quantitative research approach that involves gathering data from a sample of individuals at a specific time, providing valuable insights into the attitudes, behaviors, and characteristics of a given population or subpopulation (Creswell & Creswell, 2018). This research design allows the researchers to evaluate and understand how LCAOT pedagogy functioned during the shift to distance education.

2.2. Respondents

The respondents came from secondary public schools in the Philippines and were divided into two groups: science teachers (*n* = 42) and students (*n* = 137). The schools include both junior high schools (JHS) and senior high schools (SHS). The JHS includes students in grades 7 to 10, while the SHS consists of grades 11 to 12. Table 1 profiles the secondary science teachers who responded to the survey questionnaire. Of these, 45.2% and have physics and 42.9% have biology as their major subject. Most have been assigned to the SHS level (47.6% in grade 12 and 16.7% in grade 11) and the STEM strand (59.5%).

Table 1. Profile of secondary teachers in science (*n* = 42)

Profile		Frequency	Percentage
Major subjects handled	Physics	19	45.2
	Biology	18	42.9
	Chemistry	5	11.9
Grade level	Grade 12 (SHS)	20	47.6
	Grade 11 (SHS)	7	16.7
	Grade 7 (JHS)	5	11.9
	Grade 10 (JHS)	4	9.5
	Grade 8 (JHS)	3	7.1
	Grade 9 (JHS)	3	7.1
Strand assignment	Science, Technology, Engineering, and Mathematics (STEM) (SHS)	25	59.5
	Science, Technology, Engineering (JHS)	9	21.4
	General curriculum (JHS)	6	14.3
	Accountancy, Business, and Management (SHS)	2	4.8
Module type	Both printed and digitized	22	52.4
	Printed	13	31.0
	Digitized	7	16.7
Mode of instruction	Modular distance learning	18	42.9
	Online and modular	11	26.2
	Purely online	8	19.0
	Hybrid (online and in-person face-to-face)	5	11.9

Table 1. Profile of secondary teachers in science (*n* = 42) (cont.)

Profile		Frequency	Percentage
Frequency of synchronous meetings	Once a week per science subject	25	59.5
	Twice a week per science subject	6	14.3
	Asynchronous sessions	5	11.9
	Once a month	5	11.9
	Five times a week per science subject	1	2.4

As shown in Table 1, 42.9% of the teachers used modular distance learning as a teaching modality, including printed and digitized modules (52.4%). *Modular distance learning* is defined in this study as the use and distribution of instructional resources (printed or electronic) composed of various learning activities that are focused on a particular topic during the distance teaching and learning process. In this modality, teachers may facilitate learning and respond to student inquiries through phone calls, online messages, and social media postings (Insorio & Macandog, 2022). If distance communication is not available due to a slow internet connection or other factors, teachers who implement modular learning usually visit their students at home to retrieve modules, remediate learning, and provide assistance (Funa & Talaue, 2021). In addition, more than half of the teacher-respondents meet their students synchronously once a week through online platforms or in-person classes to provide instructions and explanations about the content of the modules. The Department of Education (DepEd, 2020b) emphasizes that teachers can have alternative working arrangements and flexible hours as long as their safety and the safety of their students remain the top priority; hence the various distance education approaches. Table 2 profiles the secondary students who answered the survey questionnaire.

Table 2 shows that student respondents mostly comprise SHS students enrolled in the STEM strand and JHS students enrolled in the general curriculum. The STEM strand has specialized courses that focus on science, technology, engineering, and mathematics. In contrast, the general curriculum has courses that are not specific to a career, which gives students a chance to weigh options at a later time. Most of the students were provided with printed modules and instructed to study through modular distance learning with weekly synchronous sessions conducted online or in face-to-face meetings. These results correspond to their teachers' answers in Table 1 that the modality most often employed is modular distance learning, which means that the teachers and students meet only once per week.

The researchers employed intensity sampling to choose interview participants from the initial pool of respondents, resulting in five teachers and ten students. Intensity sampling enables researchers to choose people who exhibit the phenomenon of interest for in-depth investigation (Patton, 1990). Teachers and students were interviewed to explain and elaborate on their answers to the survey. To further substantiate the interviewee responses, the researchers also examined the self-learning modules (SLMs) and learning activity sheets (LASs) that were used.

Table 2. Profile of secondary students (*n* = 137)

Profile		Frequency	Percentage
Grade level	Grade 11 (SHS)	60	43.8
	Grade 10 (JHS)	24	17.5
	Grade 12 (SHS)	20	14.6
	Grade 7 (JHS)	11	8.0
	Grade 8 (JHS)	11	8.0
	Grade 9 (JHS)	11	8.0
Strand	General curriculum (JHS)	39	28.5
	Science, Technology, Engineering, and Mathematics (STEM) (SHS)	38	27.7
	Science, Technology, Engineering (JHS)	18	13.1
	Accountancy, Business, and Management (SHS)	17	12.4
	General Academic Strand (SHS)	15	10.9
	Humanities and Social Sciences (SHS)	10	7.3
Module type	Printed	74	54.0
	Both printed and digitized	41	29.9
	Digitized	22	16.1
Mode of learning	Modular distance learning	80	58.4
	Purely online	47	34.3
	Online and modular	7	5.1
	Hybrid (online and face to face)	3	2.2
Frequency of synchronous meetings	Once a week per science subject	78	56.9
	Twice a week per science subject	35	25.5
	Asynchronous sessions	21	15.3
	Once a month	3	2.2

2.3. Instrument

The researchers developed a 26-item questionnaire to assess the extent to which teachers use learner-centered, action-oriented, and transformative learning in science distance education. The questionnaire was divided into three sections: (1) a learner-centered pedagogy with seven items, (2) an action-oriented pedagogy with five items, and (3) a transformative learning pedagogy with 14 items. By dividing the questionnaire into three sections, the researchers could measure the use by teachers of each type of pedagogy separately. The questionnaire content was based on established descriptions of each type of pedagogy, ensuring that the questionnaire is reliable and valid. The content of learner-centered pedagogy was based on descriptions by Weimer (2002, 2013) of learner-centered instruction. Likewise, the action-oriented pedagogy was based on Sinakou et al. (2019), and the transformative learning was based on Mezirow (1978) and Mezirow and Marsick (1978).

The researchers used a 4-point Likert scale: 4 (*strongly agree*), 3 (*agree*), 2 (*disagree*), and 1 (*strongly disagree*) to clearly define answers and prevent moderacy response bias, which occurs when uncertain individuals frequently select the middle position (Bogner & Landrock, 2016; Waltner et al., 2019). The questionnaire includes a declaration of the Philippine Data Privacy Act of 2012 and an agreement on voluntary participation.

Prior to administering the survey questionnaire, a panel of secondary school master teachers in biology (n = 5), physics (n = 4), and chemistry (n = 1) assessed the questionnaire for face and content validity. For face validity, they evaluated the questionnaire's relevance, clarity, and appropriateness using a set of 10 questions ($\bar{x}$ = 0.94). For content validity, they assessed the accuracy of the questions and whether they captured all key elements of LCAOT learning using five questions ($\bar{x}$ = 0.92). To ensure the reliability of the questionnaire, the researchers used Fleiss's kappa coefficient to measure the inter-rater agreement among the secondary school master teachers. The results indicate good agreement among evaluators for face validity (κ = 0.79, 89.33% CI, 0.57 to 1.00) and content validity (κ = 0.76, 88.00% CI, 0.45 to 1.00).

The researchers administered the questionnaire to the target respondents online through Google Forms. They kept it accessible for one month, allowing respondents sufficient time to answer at their convenience and ensuring their health and safety while completing the questionnaire at home. The researchers employed multiple methods for data collection and analysis to augment the survey questionnaire data and obtain richer and more diverse insights. This involved conducting interviews with teachers and students and reviewing self-learning modules and learning activity sheets.

The interviews with participants typically lasted between 30 and 60 minutes. The researchers asked a series of questions to gather information on the implementation of distance education in science, including the materials used, the activities employed, and their impact on student learning. Participants were also asked to share their preferences for different activities and describe how they adapted to challenges during the implementation process. Additionally, the researchers explored the LCAOT learning affecting science distance education and how it affected both teachers and students. The questions were tailored to suit both teachers and students, and follow-up questions were asked to encourage discussion and gather in-depth information.

In addition, the researchers examined the SLMs and LASs that the teachers provided to their students during this study in relation to the principles of LCAOT learning. This involved a careful evaluation of the content, structure, and format of the SLMs and LASs, as well as the teaching strategies employed by the teachers. The researchers also considered the feedback provided by the students on the usefulness of these materials in their learning process. By triangulating the data obtained from these sources with the survey responses, the researchers aimed to gain a more comprehensive understanding of the use of learner-centered, action-oriented, and transformative pedagogies in the classroom and to validate and corroborate their findings.

2.4. Data collection

The study began with an evaluation of the survey questionnaire by a panel of ten master science teachers, who provided feedback that was used to revise the questionnaire before it was distributed. The researchers then distributed the questionnaire to identified secondary science teachers using a Google Forms link shared through social media. Participants were asked to complete the questionnaire and share it with other secondary science teachers and their students. The link was active for one month, allowing respondents to complete the questionnaire at their own pace. The researchers included an ethical section in the questionnaire to inform participants that their information would be used only for research purposes and that they could opt out of the study at any time.

After analyzing the quantitative data obtained from the questionnaire, the researchers selected interviewees using intensity sampling among the respondents. The interviews were conducted synchronously online through video communication at a time convenient for the selected participants. Additionally, the researchers reviewed the self-learning modules and learning activity sheets used by the respondents to validate the quantitative data and the interview responses of the teachers and students. The researchers obtained a more comprehensive understanding of the participants' views and experiences by triangulating these methods.

2.5. Data analysis

The researchers employed descriptive statistical analysis using frequency, percentage, and ranking to examine the ordinal data from the 4-point Likert scale questionnaire. The items from the questionnaire were presented accordingly: learner-centered pedagogy (L1–L7), action-oriented pedagogy (A1–A5), and transformative learning pedagogy (T1–T14). Additionally, qualitative data from the interviews and document analysis of the SLM and the LAS were analyzed and delimited to substantiate the quantitative findings from the Likert scale questionnaire.

3. RESULTS AND DISCUSSION

In this section, the researchers present their findings based on the three pedagogical components of LCAOT learning: learner-centered pedagogy, action-oriented pedagogy, and transformative learning pedagogy. They emphasize items with a high and low percentage agreement to highlight characteristics of LCAOT education due to the change from in-person, face-to-face courses to distance learning. Additionally, they include supplementary interviews and document review data to help explain specific findings and better understand the contextual influences on the responses of teachers and students to the LCAOT questionnaire.

3.1. Learner-centeredness in distance education in science

As shown in Table 3, many teachers strongly agreed that learner-centered pedagogy in science distance education encourages students to reflect on their learning processes (L4 = 50%), requires them to exert significant effort in their learning process

(L1 = 45.2%), and involves teaching them concrete skills (L3a = 42.9%). The teachers agreed that it includes teaching students how to think (L3b = 54.8%) and solve problems (L3c = 54.8%). In the interview with the teachers, they emphasized activities that allowed students to reflect on their synchronous and asynchronous learning by asking them what they have learned, what they still want to learn, what inquiries they have about the topic, and how they plan to apply the information gained during the lesson, among other questions. Other teachers used a KWL chart (what they *Know*, *Want* to know, and have *Learned* about the lesson) to help the students reflect. According to Duran and Duran (2004), KWL charts are usually used in the engagement part of the 5Es (Engage, Explore, Explain, Elaborate, and Evaluate) model – a teaching model generally followed by secondary science educators in the Philippines – to harness attention and engagement. Nevertheless, the placement of KWL charts in the SLM and LAS in the evaluation part helps teachers qualitatively examine student learning in the form of reflection. During synchronous sessions, they ask students to reflect in person or online using video conferencing tools through recitations and written output. Correspondingly, they ask students to write their responses on their modules or answer sheets during asynchronous sessions. Given this scenario, teachers can respond to students faster when classes are conducted synchronously rather than asynchronously. The teacher's role is imperative when facilitating scientific arguments (Ramallosa et al., 2022), whether being done in synchronous or asynchronous sessions. However, according to teachers, if their students need immediate responses during asynchronous sessions, some teachers choose to communicate with their students through text messages, phone calls, or social media.

Table 3. Learner-centeredness in science distance education as perceived by teachers (*n* = 42) and students (*n* = 137)

Item	Statement	Teachers				Students			
		SA %	A %	D %	SD %	SA %	A %	D %	SD %
L1.	Distance education in science requires students to exert significant effort in their learning process.	45.2	42.9	11.9	0	9.5	75.4	13.1	2.9
L2.	Distance education in science makes students do more of the learning tasks.	31.0	66.7	2.4	0	15.3	64.2	16.8	3.6
L3.	Distance education in science includes the following:								
a.	teaching concrete skills,	42.9	35.7	21.4	0	15.3	65.0	19.7	0
b.	teaching students how to think,	42.9	54.8	2.4	0	12.4	75.9	11.7	0
c.	solving problems,	42.9	54.8	2.4	0	16.1	81.0	2.9	0
d.	evaluating evidence,	31.0	69.0	0	0	12.4	79.6	8.0	0
e.	analyzing arguments, and	16.7	83.3	0	0	5.1	92.7	2.2	0
f.	generating hypotheses.	31.0	69.0	0	0	12.4	87.6	0	0

Table 3. Learner-centeredness in science distance education as perceived by teachers (*n* = 42) and students (*n* = 137) (cont.)

Item	Statement	Teachers				Students			
		SA %	A %	D %	SD %	SA %	A %	D %	SD %
L4.	Distance education in science encourages students to reflect on what they are learning.	50.0	50.0	0	0	35.8	58.4	2.9	2.9
L5.	Distance education in science encourages students to reflect on how they are learning.	35.7	59.5	4.8	0	24.8	72.3	2.9	0
L6.	Distance education in science motivates students by giving them some control over learning processes.	23.8	71.4	4.8	0	12.4	71.5	5.1	10.9
L7.	Distance education in science encourages collaboration among students.	16.7	31.0	50.0	2.4	19.7	60.6	9.5	10.2

According to McCombs (2000), learner-centered pedagogy views students as co-creators and partners in teaching and learning. It involves students in making decisions about how and what they learn and how that learning is measured (McCombs, 2000). As shown in Table 3, many teachers strongly agreed that distance education in science requires students to exert significant effort in their learning process (L1 = 45.2%). During the interviews with teachers, it was mentioned that they used instructional materials such as SLMs and LASs, which necessitated considerable student effort. These materials contain concrete instructions and activities that guide students in acquiring knowledge and skills with minimal assistance from teachers, parents, or guardians. For instance, they contain reflective activities that encourage students to evaluate their learning, contextualized problems to practice their decision-making skills, and other supplemental resources such as additional reading materials and links to educational videos and interactive online activities for a better understanding of the contents.

However, some teachers disagreed that distance education in science encourages collaboration among students (L7 = 50%), includes instructing concrete skills (L3a = 21.4%), or requires students to exert significant effort in their learning process (L1 = 11.9%). This is in parallel with the findings of Funa and Talaue (2021) that one of the problems in distance education is the implementation of activities that promote interaction and collaboration among students. According to the interviewed teachers, they did not allow their students to personally interact with one another during the first year of the COVID-19 pandemic to prevent the spread of viral infection. Interactions were only permitted online or through long-distance communications. However, as many students have now been vaccinated against the COVID-19 virus, some teachers are slowly allowing their students to interact face-to-face if they follow health protocols such as wearing face masks and shields, maintaining a two-meter distance from one another, and washing hands thoroughly with soap.

Similarly, the lack of interaction between students and teachers is why some teachers hesitate to believe that distance education includes instruction in concrete skills. Based on the interviews, these teachers prefer in-person, face-to-face synchronous classes where they can offer precise instructions on skills and guide students through demonstrations of practical skills, especially if their immediate response is required and the teaching of the skills necessitates meticulous health and safety procedures. These results are in parallel to the findings of Dahlstrom-Hakki et al. (2020), Edelbring et al. (2020), Libasin et al. (2021), and Wang and Wang (2021) that synchronous classes are preferred by students and are more effective in improving their academic performance than asynchronous classes. Synchronous classes can be conducted online; however, based on the interviews with the teachers, students preferred in-person classes as they needed help finding a favorable environment to study in and lacked the equipment, Internet connections, and facilities at home, such as laboratory paraphernalia, for doing science experiments.

In addition, the teachers mentioned that in some cases, activity sheets were completed by parents or guardians and not by the students themselves. As a result, although most believed that distance education robustly involves students in learning, 11.9% disagreed with item L1. This perception is supported by the findings of Anzaldo (2021) that some teachers did not support modular distance learning because some activity sheets were answered by the parents or guardians only, and some students had difficulty accomplishing the modules without teacher supervision. Based on the interviews, teachers believe that one reason parents completed the activity sheets rather than guiding students to do so was a lack of patience and time. As a result, parents answered the modules to expedite the time spent on them. Similarly, the students confirmed during the interview that they are sometimes unable to complete their assigned activities due to the sheer volume of tasks they are expected to undertake each week. These include school-related activities and household chores that they are expected to help with. Additionally, some students mentioned that their parents did some of the activities on their behalf.

When teachers were asked about the issue of parents or guardians completing activity sheets instead of students, they mentioned resolving it by properly communicating to parents and guardians their roles in distance education, emphasizing the importance of giving students the autonomy to complete tasks independently, or with their assistance, and to gain knowledge with each accomplished task. Establishing effective and reliable communication between teachers, students, and parents or guardians is critical in distance education. According to Rashıd and Rashıd (2012), teachers should be knowledgeable about numerous aspects of communication, including but not limited to the diverse and appropriate methods for students to learn and for parents and guardians to understand their roles in distance education. Based on the teacher interviews, teachers are aware that more than communication alone is needed to prevent parents from answering the modules without the involvement of students. They found ways to identify these parents by comparing the students' handwriting from their previous modules to the newly submitted ones and checking the choice of words and construction of sentences. Nonetheless, there are certain situations where the guidance and assistance of parents or guardians are necessary. One such example is during home-based experiments, where safety considerations take precedence and extra supervision may be needed to ensure that the experiment is conducted safely and correctly.

When it comes to student perceptions, as shown in Table 3, most agreed that the learner-centered approach in science in a distance education setting encourages students to reflect on what and how they are learning (L4 = 58.4% and L5 = 72.3%) and to collaborate (L7 = 60.6%). These student perceptions are consistent with those of the teachers. However, they differ only in their perceptions of student interaction and collaboration. As revealed in the student interviews, activities that involved grouping or working as a team were limited because they knew their teachers would want them to avoid physical contact to prevent infection and the spread of the COVID-19 virus. However, when they had difficulty accomplishing their modules and activity sheets, they tended to ask their classmates before their parents and teachers. These interactions among students mostly happened through phone calls, text messages, and video-based communications. Likewise, in remote places where the Internet and phone service are unavailable, they turned to their closest peers in the neighborhood to ask for assistance or brainstorm answers to their activities.

The students admitted during the interviews that the shift from conventional in-person, face-to-face classes to distance learning resulted in various difficulties, such as finding ways of interaction and collaboration with their classmates. This resulted in some students disagreeing that distance education in science encourages collaboration. They mentioned that they still preferred conventional, in-person, face-to-face classes over distance education as the interaction and collaboration with their classmates are more frequent, thus engaging and motivating them to study and learn. As a result, they devised means to talk with and meet their classmates and peers, whether virtually or physically. These findings are parallel to those of Funa and Talaue (2021) and Marcial et al. (2015), who found that distance learning results in various educational challenges, including interaction and collaboration among students, that need to be addressed in order to promote student engagement and motivation and achieve quality education even in unprecedented times.

Table 3 demonstrates that students disagreed that distance education in science requires them to complete more learning activities (L2 = 16.8%) and contains explicit skill training (L3a = 19.7%). According to the interviewed students, although they were required to complete the activities outlined in the SLMs and LASs, these were limited compared to the activities when courses were held in person and in physical school facilities. The reason for the limited tasks is the provision of Most Essential Learning Competencies to simplify the curriculum and reduce the stress associated with learning and teaching during the pandemic (DepEd, 2020a). Additionally, some learners reported that some tasks are still too complex for them to complete, necessitating the assistance of their parents, guardians, or older siblings. However, some students relied entirely on their parents, guardians, or older siblings to complete their SLMs and LASs due to distractions, such as noisy environments, chores at home, lack of set boundaries for accessing technologies (e.g., social media and video games), procrastination, and distracting activities of people in their surroundings.

Learner-centered pedagogy has been shown to be beneficial in increasing student academic performance and engagement, including distance education, whether online or modular (Funa & Prudente, 2021; Funa & Talaue, 2021; Hannum et al., 2008; Pinchot & Paullet, 2021). These findings highlight the importance of learner-centered pedagogy in distance education, whether online or modular, in promoting student academic performance and engagement. As perceived by teachers and students, learner-centered pedagogy involves students in the teaching and learning process, making them co-creators and partners in their education. Most teachers surveyed agreed that distance education in science requires students to exert significant effort in their learning process, encourages reflection on learning processes, and includes teaching students how to think, solve problems, and acquire concrete skills. Through various activities such as reflection, recitations, and written output, teachers encourage students to take control of their learning, collaborate with peers, and think critically about their learning experiences. By doing so, learner-centered pedagogy in distance education can help students become more engaged and effective learners.

3.2. Action orientation in distance education in science

Table 4. Action orientation in science distance education as perceived by teachers (*n* = 42) and students (*n* = 137)

Item	Statement	Teachers				Students			
		SA %	A %	D %	SD %	SA %	A %	D %	SD %
A1.	Distance education in science encourages students to take action as active citizens in community decisions on real-life problems.	33.3	59.5	7.1	0	19.7	70.8	6.6	2.9
A2.	Distance education in science promotes the sharing of power and responsibility between teachers and students.	45.2	54.8	0	0	19.7	73.7	3.6	2.9
A3.	Distance education in science promotes collective action by students in solving a real-life issue.	21.4	69.0	9.5	0	12.4	71.5	16.1	0
A4.	Distance education in science motivates students to get involved in the community.	11.9	81.0	7.1	0	16.8	65.7	13.9	3.6
A5.	Distance education in science promotes interdisciplinarity (integrating various fields of knowledge) to address sustainable development issues.	28.6	61.9	9.5	0	12.4	75.9	11.7	0

As shown in Table 4, the majority of the teachers perceived that distance education in science promotes action orientation; expressly, they strongly agreed that there is sharing of power and responsibility between teachers and students (A2 = 54.8%) and encouragement for students to take action as active citizens in community decisions on real-life problems (A1 = 59.5%). During the teacher interviews, they expressed the belief that quality distance education in science can be achieved if teachers and students share responsibility for learning. However, because of the sudden shift from conventional education to distance learning during the pandemic, teachers experienced difficulty determining their specific roles, identities, and responsibilities.

Keiler (2018) defined teachers' roles as what teachers do in the classroom and their identities as what they think of themselves and their classroom roles. These roles and identities may evolve based on personal beliefs and professional experiences (Grier & Johnston, 2009). For instance, one of the interviewed teachers mentioned that distance education adversely affected her way of teaching. She was used to in-person classes using the chalk-talk method to explain her lessons. However, during the pandemic, she felt that her role as a teacher was limited to distributing, collecting, and checking the SLM and LAS every week, especially for students lacking a computer and living in an area without an Internet connection.

On the other hand, another teacher stated that the sudden shift in education positively affected his perceptions of his role and identity. He explained that distance education allowed him to incorporate new technologies and software applications into his instruction and emphasized his role as a learning facilitator. These results show that teachers need to clearly define their roles, identities, and responsibilities to guide students while properly sharing learning responsibilities. Thus, programs that can help teachers who are confused to clearly define their roles and identities during the shift to distance education are essential.

Action-oriented pedagogy is a student-centered approach emphasizing the shared learning responsibility between teachers and students (Sinakou et al., 2019). In the context of distance education in science, teachers have adopted this approach by empowering learners to take ownership of their learning. This has been achieved by providing different options for completing self-learning modules and learning activity sheets and by offering various support channels such as online videos, links to additional resources, and phone numbers for queries.

Despite these efforts to enhance the learning experience, the pandemic has forced teachers to make difficult decisions regarding resource allocation. In some cases, the printing costs associated with the SLM have been deemed excessive, leading to the creation of the LAS, which focuses more on practical activities. While the LAS provides opportunities for application and practice, the SLM offers a more comprehensive learning experience by integrating theoretical concepts and practical exercises. Nonetheless, the teachers have ensured that both approaches are supported with additional resources and communication channels to assist students in their learning journey.

As shown in Table 4, most teachers agreed that action-oriented pedagogy in distance education involves students in solving real-life problems (A1 = 59.5%). During the interviews, teachers mentioned that the COVID-19 pandemic has made some of them realize more fully the importance of building the ability of youth to lead and be involved in solving real-world problems, as they are expected to become leaders in the future. According to the teachers interviewed, many Filipino adults still believe in superstitions and practices that are without scientific basis. This behavior is evident in how they manage the prevention and treatment of COVID-19 infection. This view is supported by the finding of Besa et al. (2021) that millennials born between 1981 and 1996 still believe in superstitions despite the availability of credible sources that can be accessed through different forms of technology. The teachers interviewed stressed the importance of educating young people in evidence-based problem-solving to create a future generation that will engage in evidence-based decision-making. Therefore, involving students in solving real-world problems using scientific methods is critical. For example, in their activity sheets, students are asked questions about how vaccines help control infection and how they can promote their use, demonstrating the application of scientific knowledge to address a real-world problem. By adopting an action-oriented pedagogy, teachers can empower students to participate actively in problem-solving and contribute to building a scientifically literate society.

Students are exposed to the community differently during in-person classes than during distance learning. During conventional in-person classes, some activities required the students to immerse themselves in the community to observe, interview, and better understand community problems. In contrast, the physical exposure of students was prevented or limited for health and safety reasons by adopting distance learning during the COVID-19 pandemic. Instead, the use of available technologies, such as conducting interviews by text messaging, online chat, and phone and video calls, was maximized. The change in how students immerse themselves in the community has affected how they address community problems. For instance, student training for the community was previously held in person. However, some students are now leaning toward using telecommunications and several computer applications to facilitate activities.

In contrast, some teachers disagreed that distance education in science promotes collective action by students to solve real-life problems (A3 = 9.5%) and an interdisciplinary approach to address sustainable development issues (A5 = 9.5%). When interviewed, they mentioned that collaborative activities were limited during the COVID-19 pandemic, which parallels the findings of Funa and Talaue (2021). During the interviews with teachers, it was suggested that a specialized pandemic or emergency pedagogy that promotes the wise use of technology for student collaboration and collective action in solving real-life issues and sustainability problems is essential in distance education. They emphasized that specific teaching strategies should be implemented to address these concerns.

Regarding student perceptions, Table 4 shows that most students agreed with items A2 (73.7%) and A1 (70.8%), signifying that their perceptions of distance education in science are consistent with those of their teachers. During the student interviews, they mentioned several difficulties in learning with distance education, such as a lack of computer hardware, slow Internet connections, and unfavorable learning environments. However, they were aware that their roles as students changed with distance education. They stated that the responsibility for their learning became more apparent than in conventional classes. This parallels the findings of Funa et al. (2023) that students in distance education need to improve their self-regulated learning strategies.

Furthermore, the students mentioned that activities in their SLMs and LASs that addressed real-life problems in the community encouraged them to practice their problem-solving skills. However, these activities were limited to the modules and activity sheets and did not physically immerse them in the community. This perception of the students is shown by their responses to item A4, in which 13.9% disagreed or strongly disagreed that distance education in science motivates students to get involved in the community.

In the survey, the researchers found that 16.1% of students disagreed that distance education in science promotes collective action in solving real-life issues (A3), and 6.6% disagreed that it involves students solving such issues (A1). These findings align with the perspectives of some teachers, who also shared similar concerns. Both students and teachers mentioned that performing collaborative activities during the pandemic has been challenging, particularly for students who lack the means to engage in distance and online communications and rely solely on printed modules delivered to their homes. It is crucial to recognize that an action-oriented pedagogy is essential for achieving high-quality education that empowers students to become active problem-solvers (Rieckmann, 2018). This teaching approach is fundamental to distance education, where teachers must ensure that students are effectively engaged in collective action toward solving real-life problems.

To ensure action orientation in distance education, continuous evaluation and improvement of the implementation of distance education strategies is imperative. This includes the activities and assignments provided to students and how teachers facilitate discussion, collaboration, and reflection in action orientation. By prioritizing student-centered approaches that encourage critical thinking, creativity, and active participation, teachers can ensure that students are equipped with the skills and knowledge needed to navigate distance education challenges and succeed in their academic pursuits.

3.3. Transformative pedagogy in distance education in science

Table 5 shows that many teachers strongly agreed that distance education in science encourages self-examination among students (T2 = 50%) and motivates them to assess their knowledge critically (T3a = 50%). The results for T2 and T3a agree with those obtained for L4, indicating that distance education in science encourages students to reflect on their learning processes. In the earlier part, the teachers were asked about activities promoting reflection. They mentioned that they use the KWL charts during the synchronous and asynchronous sessions to evaluate student learning from reflection. Moreover, when asked what other reflective activities they included besides the SLMs and LASs, they mentioned reflective journaling and mind mapping.

Table 5. Transformative learning in science distance education as perceived by teachers (*n* = 42) and students (*n* = 137)

Item	Statement	Teachers				Students			
		SA %	A %	D %	SD %	SA %	A %	D %	SD %
T1.	The problems presented by the teacher during distance education in science promote curiosity and investigation.	31.0	69.0	0	0	14.6	85.4	0	0
T2.	Distance education in science encourages self-examination among students.	50.0	50.0	0	0	24.8	72.3	0	2.9
T3.	Distance education in science motivates students to critically assess their								
a.	epistemic,	50.0	50.0	0	0	31.4	62.0	6.6	0
b.	sociocultural, and	33.3	59.5	7.1	0	15.3	76.6	5.1	2.9
c.	psychological assumptions.	31.0	69.0	0	0	18.2	76.6	5.1	0
T4.	Distance education in science enables students to recognize their discontent.	16.7	78.6	4.8	0	21.9	75.9	2.2	0
T5.	Distance education in science enables students to share their discontent with others for change or transformation.	11.9	83.3	4.8	0	19.7	64.2	16.1	0
T6.	Distance education in science allows students to explore new								
a.	roles,	35.7	59.5	4.8	0	24.1	69.3	6.6	0
b.	relationships, and	23.8	69.0	7.1	0	12.4	73.0	9.5	5.1
c.	actions.	11.9	81.0	7.1	0	19.7	55.5	24.8	0
T7.	Distance education in science motivates students to plan a course of action.	28.6	59.5	11.9	0	15.3	59.9	24.8	0
T8.	Distance education in science allows students to acquire knowledge by implementing their planned course of actions.	23.8	64.3	11.9	0	23.4	76.6	0	0
T9.	Distance education in science allows students to acquire skills by implementing their planned course of action.	11.9	64.3	23.8	0	19.0	81.0	0	0
T10.	Distance education in science encourages students to try new roles in the community.	23.8	69.0	7.1	0	14.6	70.8	14.6	0
T11.	Distance education in science fosters building of competence in new roles.	23.8	69.0	7.1	0	15.3	69.3	12.4	2.9
T12.	Distance education in science nurtures self-confidence in new roles.	38.1	54.8	7.1	0	15.3	67.2	13.9	3.6

Table 5. Transformative learning in science distance education as perceived by teachers (*n* = 42) and students (*n* = 137) (cont.)

Item	Statement	Teachers				Students			
		SA %	A %	D %	SD %	SA %	A %	D %	SD %
T13.	Distance education in science encourages building relationships.	26.2	66.7	7.1	0	10.9	65.0	23.4	0.7
T14.	Distance education in science promotes reintegration into one's life on the basis of conditions dictated by one's perspectives.	26.2	66.7	7.1	0	10.2	81.8	8.0	0

On the one hand, reflective journaling serves as a lens for teachers to examine the subjective views of students through their thoughts and feelings about their lessons and learning experiences. Reflective journaling has three types: dialogue, class interactive (team), and personal (Hubbs & Brand, 2005). The personal journal is the most common type used in distance education, based on the teachers interviewed and the documents reviewed. The personal journal revealed students' thought processes. However, according to Hubbs and Brand (2005), due to the private nature of personal journals that do not allow feedback from others, the crucial skill of critical assessment is unlikely to be developed, leading to the conclusion that class interactive and dialogue journals are better for students' personal and professional growth and development. Therefore, it is vital to critically evaluate the effectiveness of the various types of reflective journals included in the SLMs and LASs.

On the other hand, mind mapping is a learning activity in which a key idea is placed at the center of a sheet of paper, and students must surround that idea with information from various sources displayed as keywords (Edwards & Cooper, 2010). Based on the interviews with teachers, they used this technique for students to summarize their knowledge and different perspectives on a given idea or ideas. In this manner, teachers may quickly determine the origins of a particular body of information obtained by the students.

In comparison, 23.8% of teachers disagreed that distance education in science allows students to acquire skills by implementing their planned courses of action (T9), 11.9% disagreed that distance education in science motivates students to plan courses of action (T7), and 11.9% disagreed that distance education in science allows students to acquire knowledge by implementing their planned course of action (T8). These items are related to one another and focus on learning by planning a course of action and carrying it out. During the teacher interviews, it was revealed that teachers implement a teaching strategy that involves giving students real-world problems relevant to their present topic. The students are then tasked with creating a planned course of action that uses their acquired knowledge from the lesson to help solve these real-world problems. These types of activities are typically integrated before or after the actual lesson. The teachers who were interviewed explained that the planned course of action created by the students typically focuses on solutions that involve in-person appearance or community immersion, depending on the problem. However, due to the pandemic, some solutions need to be limited to the students' homes. Therefore, the teachers provided ideas on how students can still perform their planned actions within their localities, despite the controlled and limited area. This activity encourages creativity and critical thinking and emphasizes adapting to current circumstances.

According to Voet and De Wever (2018), although activities such as immersion may not significantly affect students' content knowledge, they have significant effects on other learning aspects, such as procedural knowledge and self-efficacy. They recommended the use of supplemental reflection activities, such as activities involving conceptual change strategies, to increase learning (Voet & De Wever, 2018). According to Kagan (1992) and Korthagen (2013), conceptual change strategies would help students make often-implicit views explicit, expose the inadequacies or drawbacks of their views, and integrate alternative and logically sound viewpoints. Hence, these strategies underscore transformative learning.

Because of restrictions due to the COVID-19 pandemic, teachers did not encourage their students to implement these planned courses of action; instead, they were written on the modules or presented during synchronous classes. Hence, they recommend developing activities involving students in solving real-world problems and implementing their planned course of action without requiring them to go outside and risk their health and safety, especially during this pandemic that limits the movement of both students and teachers. Nevertheless, teachers believe that exposing students to the community is critical for learning, but student safety is their top priority.

In all, 31.4% of students strongly agreed and 62.0% agreed that distance education in science motivates them to assess their knowledge critically (T3a). According to the students, in addition to short quizzes and tests on the SLMs and LASs to evaluate their learning, they also needed to evaluate their learning by answering the KWL charts. Students mentioned that activities such as the KWL charts helped them recall their prior knowledge and check whether this knowledge had improved after having completed the activities in their SLM or LAS. These results parallel those of item T2, in which 24.8% of students strongly agreed and 72.3% agreed that distance education in science encourages self-reflection or examination (T2). According to Raikou (2019), activities leading toward self-examination enrich student experiences as students shift toward self, teacher, and personal development and find their roles and identities. The student perceptions coincide with the findings of Raikou (2019), as shown by their answers to T6a, where 24.1% strongly agreed and 69.3% agreed that distance education in science allows students to explore new roles.

In the interviews, the students mentioned that reflective activities in distance education enabled them to find their new roles. For instance, one student mentioned that they did not need to keep track of time in school because alarms would alert them when it was time for each course. However, they had to manage their time carefully in distance education, except in synchronous sessions, because they did not share a study plan with their classmates. Additionally, students mentioned that although they had more freedom to arrange their schedules and complete school tasks at their convenience, they sometimes needed more time due to distractions such as playing games, watching television, or using their mobile phones. Reflective activities in remote education highlight students' role as active learners in this respect. They may have more freedom, but they must still plan and manage their time well to complete the weekly tasks. According to Matsuyama et al. (2019), students may quickly transfer from teacher-centered to learner-centered learning. They begin to build their self-image, self-reflect, and seek diverse learning approaches. Thus, reflective activities are critical components of transformative pedagogy in distance education.

Regarding the exploration of new relationships through distance education in science, it was found that 5.1% of students strongly disagreed and 9.5% disagreed (T6b). In addition, 23.4% of them disagreed and 0.7% strongly disagreed that distance education helps build relationships among them (T13). According to Lee et al. (2021), although teacher-student engagement remained successful throughout the pandemic, the quality of student-student relationships and interactions declined. The absence of face-to-face contact led students to develop a negative attitude toward group work as a component of their online learning and substantially and detrimentally affected their feeling of community and overall contentment, which made their teachers unable to successfully implement collaborative learning despite their competence in facilitating student learning (Lee et al., 2021). In addition, 24.8% of students disagreed that distance education in science allowed them to explore new actions (T6c) and motivated them to plan courses of action (T7). The results of the teachers' responses regarding planned courses of action are similar to those obtained from the student interviews. Students mentioned that distance education hindered their ability to explore the community, which restricted their ability to plan courses of action to address issues affecting the community.

Implementing transformative pedagogy in distance education requires continuous monitoring and evaluation, especially given the ever-changing nature of real-life events. Identifying potential barriers and making necessary adjustments is crucial to ensure students have the resources and opportunities to apply their learning to real-world situations. By regularly monitoring and evaluating the effectiveness of the teaching strategy, educators can remain responsive to students' needs and experiences and adapt their approach accordingly. These activities ensure that the teaching strategy remains relevant and practical despite changing circumstances to better equip students with the skills and knowledge needed to address real-world issues, even in the face of uncertainty and complexity.

4. CONCLUSIONS AND RECOMMENDATIONS

The researchers examined teacher and student perceptions of distance education in science, focusing on learner centeredness, action orientation, and transformative learning. The researchers explored how educators and students coped with challenges and sought learning opportunities as in-person classes transitioned to remote learning environments.

The findings indicate that the principles of LCAOT learning are apparent in science distance education, as recognized by both students and teachers. These principles are exemplified by the use of tools such as KWL charts, personal journals, mind mapping strategies, and distinctive collaboration and interaction methods that differentiate distance learning from traditional education. Implementing both synchronous and asynchronous learning modes also showcases LCAOT learning. Furthermore, this form of education fosters new identities and roles for both students and teachers and requires significant shifts in the adoption of technological tools used for educational purposes.

The study reveals that teachers and students faced challenges transitioning from conventional in-person classes to distance education. Despite preferring synchronous sessions, most students had to rely on asynchronous modes of instruction due to inadequate computer hardware and Internet connectivity, which in turn led to a decrease in interaction and communication with their peers and teachers. Some parents answered the modules themselves to save tutoring time, limiting students' learning opportunities. Teachers and students also needed clarification regarding their roles and identities during the initial phase of the transition, and students faced limitations in solving real-world problems in their communities. Lastly, the effectiveness of the given activities during distance education, including the types of journals used, requires evaluation.

Both students and teachers responded to the challenges they encountered during the transition to distance education. They strengthened communication by various means, such as text messages, phone calls, and social media, during asynchronous sessions. Students who experienced difficulties in completing modules and activities collaborated with their peers, and teachers frequently communicated with parents and even visited students at their homes. Furthermore, distance education in science offers opportunities for both students and teachers to explore new roles and identities, enhancing the quality of the teaching and learning process.

The researchers recommend using the developed instrument and continuing to evaluate and monitor the effectiveness of the teaching strategies employed in distance education in science. This recommendation may enable teachers to remain responsive to the needs and experiences of their students and adapt their approach accordingly. Furthermore, the researchers recommend using the survey questionnaire to assess and evaluate LCAOT learning in different contexts, including courses other than science, to strengthen the validity and reliability of the instrument. Additionally, further studies should be conducted on the effectiveness of LCAOT learning and its impact on various activities in improving student academic achievement in distance education.

5. LIMITATIONS OF THE STUDY

The findings of this study are limited to science education and the participants, consisting of secondary students and science teachers who voluntarily responded to the online survey questionnaire. Nonetheless, the findings provide valuable insights into how teachers and students perceive LCAOT learning in distance education. It is crucial to acknowledge the impact of the COVID-19 pandemic on the study's limitations, as the sudden shift to remote learning and the unique challenges it presents may have affected the participants' perceptions and experiences of LCAOT learning. Therefore, the generalizability of the study findings to non-pandemic contexts should be considered.

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