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Online Collaborative Learning Platforms in Science: Their Influence on Attitude, Achievement, and Experiences

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Abstract—This study investigates the influence of online collaborative learning platforms on students' attitudes, achievements, and experiences. Through a mixed-methods research approach, 100 students from public and private higher education institutes pursuing a Bachelor of Secondary Education major in Science responded to the online survey. At the same time, ten of them participated in the online interviews. Collected data were analyzed using descriptive statistics, *t*-tests for independent samples, simple linear regression, and thematic analysis. Study findings revealed that the students were generally satisfied (μ=4.08) with the collaborative learning platforms, had positive attitudes toward Science (μ=4.10), and got outstanding Science achievement (μ=1.85). The students from public and private universities were comparable in terms of the use of collaborative learning platforms (p=.302) and students' satisfaction (p=.868), science attitudes (p=.830), and achievement (p=.158). Moreover, the students were challenged due to unequal participation, different perspectives, and lack of communication and self-confidence. Nevertheless, they also experienced opportunities such as developing social and higher-order thinking skills and values inculcation. In conclusion, collaborative learning platforms have helped and challenged students in learning science.

Keywords: collaborative learning platforms, Science, attitude, achievement, challenges, opportunities

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1. INTRODUCTION

Science-collaborative learning systems are becoming increasingly common in modern classrooms (Chen et al., 2021). Through technology, these platforms offer a setting for students to collaborate on projects and tasks connected to Science. These platforms include online discussion boards, virtual classrooms, collaborative software, and electronic portfolios. By utilizing these platforms, educators hope to improve student's learning experiences and foster the growth of their communication and collaborative abilities (Hursen & Bas, 2019; Liu et al., 2020; Alam, 2022; Boholano et al., 2022; Hermoso et al., 2022).

The use of collaborative learning platforms in scientific classrooms has been examined in the read literature. These platforms were evaluated for their effectiveness in collaborative learning strategies. Arevalo (2013) implemented wikis in a pilot study consisting of 148 study participants. His results pointed out that students had a positive perception toward using wiki activities, and academic scaffolding is needed to assist students in using technology-based tools in the classroom. Hsu and Shieu (2018) explored the influence of collaborative technology through Google Applications on students' perceptions of teaching, cognitive, and social presence. With the use of Google

Applications, social presence has predicted the students' cognitive presence in online collaboration; this finding suggested that collaborative applications can influence students' engagement online.

However, the use of these platforms has skyrocketed due to the constraints of the pandemic. Al-Husban (2020) used online asynchronous discussion forums, assessed students' critical thinking skills using a content analysis design, and attributed their acquisition of essential critical thinking skills to their engagement in online discussion forums. Banat (2021) utilized Mendeley as a tool for collaborative learning and evaluated its effectiveness through a qualitative research design. He revealed that Mendeley could enhance collaboration between peers and teachers, positively impacting students' skill acquisition. Ansari and Khan (2020) explored the role of social media in online collaborative learning through an empirical study analyzed using structural equation modeling. Their study found that social media platforms can significantly impact students' interaction with their peers, teachers, and online sharing behavior. In a one-group pretest-posttest experimental design, Dwikoranto et al. (2021) applied project-based laboratory learning to increase students' online collaboration and process skills. They noted a significant improvement in students' collaboration while a moderate increase in their process skills.

Other studies did not specify platforms but investigated various aspects of collaborative learning in online settings. Mustakim et al. (2020) explained the effects of online collaborative learning using platforms, e.g., learning management systems and videoconferencing applications, via a qualitative research method. Although these online platforms were perceived to be less effective than face-to-face classes, these platforms have promoted collaboration amidst remote learning in the first stage of the pandemic. Using quantitative methods, Shonfeld (2021) examined student-teacher satisfaction with online collaborative learning. Based on the results, satisfaction with online collaborative learning was influenced by the students' collaborative experience, positive experiences, and openness, accounting for as much as 63% of the total variance. Similarly, using a mixed-method design, Cheng et al. (2023) investigated the students' satisfaction with online collaborative learning. Their findings indicated a high cognitive load that lowered students' perceived usefulness of online platforms, leading to low satisfaction levels with collaborative learning.

The researchers have firsthand experience with the advantages of implementing collaborative learning systems in Science subjects. Students can ask questions, exchange ideas and opinions, and collaborate on these platforms to find solutions. They also allow to support students more individually and closely monitor their development. Collaborative learning platforms in scientific classrooms can improve students' and teachers' learning outcomes. Although collaborative learning platforms are becoming increasingly common in scientific classrooms, more study still needs to be done on how they affect students' attitudes, achievements, challenges, and opportunities. While some studies have looked at these issues (e.g., Shonfeld, 2021; Cheng et al., 2023), more thorough research is required to examine the many variables affecting these platforms' benefits. Moreover, the researchers' personal experiences have emphasized the necessity of examining the best methods for using these platforms in science classrooms and any difficulties teachers might have in doing so.

The study aimed to address the research gap by investigating the influence of collaborative learning platforms on student attitudes, achievements, challenges, and opportunities in science classrooms in universities in Cebu City, Central Visayas, Philippines. This study's findings will significantly impact how scientific instructors and

decision-makers approach their work. Educators may make better choices about integrating collaborative learning platforms into their lessons by researching how they affect students' attitudes and academic performance. Additionally, policymakers can create regulations encouraging the efficient use of collaborative learning platforms in scientific classrooms by identifying the challenges and opportunities of implementing these platforms. Overall, this study has the potential to support efforts to enhance science instruction and get students ready for the 21st century.

2. METHODS

2.1 Research Design

A mixed-methods research approach that included quantitative and qualitative elements was adopted for the current investigation. A descriptive-regressional methodology was used in the quantitative part of the study to collect quantifiable information on how collaborative learning platforms affected students' attitudes and achievement in science classes. This method is suitable for this study because it enables the researchers to quantify the relationship between the independent variable (i.e., use of collaborative learning platforms) and the desired outcomes and to spot any significant correlations (Stangor & Walinga, 2014). The study's qualitative component used a narrative inquiry design to gather and analyze data in the form of stories, narratives, and personal experiences. The researchers can analyze the opinions and experiences of students and teachers regarding the usage of collaborative learning platforms in science classrooms. This design discovers themes or patterns from their accounts thanks to the study's proper design (Butina, 2015).

2.2 Participants

The study was conducted in public and private universities and colleges in Cebu City, Philippines. These are well-known universities in the locality, including two public universities (University 1 and 2) and three private institutions (University 3, 4, and 5). University 1 houses the center of excellence of teacher education, while University 2 includes both teacher and technical education as a technological university. University 3 and University 4 are sectarian schools offering science education to deserving teachers-to-be. Lastly, University 5 is a non-sectarian school with three other campuses in the city. All these universities offer Bachelor of Secondary Education (BSEd) in Science programs, recognized by the higher education commission and accrediting bodies.

One hundred students taking up BSEd in Science participated in the study, randomly selected from among the said higher education institutions during their online learning classes. Most of these students are aged 20-25 (92%) and females (73%). Most are in their third-year level (73%) and have a monthly household income of less than Php 8,333.00 or approximately USD 155.00 (85%). Fifty percent comes from public institutions and the other half from private ones. In addition, 20 students from the said sample were interviewed for the narrative inquiry. They were chosen regardless of gender and year level as long as they participated in the previous survey.

2.3 Research Instruments

The researchers adapted instruments from the available literature to obtain data on four measures: collaborative learning platforms, satisfaction, and science attitudes. The academic achievement was collected as part of the demographic profile sheet, while

the experiences were gathered using a semi-structured interview guide. Table 1 presents the different instruments employed in the study.

Table 1. Instruments of the study

Instrument	Measure	Reference
Profile Sheet	Demographics, including Science grades	Authors
Survey	Frequency of the use of collaborative learning platforms	Muuru et al. (2014)
	Students' satisfaction	Al-Rahmi et al. (2013). Brush and So (2008)
	Science attitudes	Backer et al. (2018).
Interview guide	Experiences (challenges and opportunities)	Authors

2.4 Procedures

The study underwent several data-gathering procedures. Before data gathering, the research team secured an ethics certification (no. 789/2021-04) from the University Research Ethics Office. After confirming this certification, the team asked permission from the university heads and asked for informed consent from the student participants. Once permitted, the researchers administered the online survey and, consequently, the online interview.

Student participants with collaborative learning platform experience in science classes received the online survey. A set of questions were used in the survey to elicit information regarding their use, satisfaction, attitudes, and academic achievements, and the respondents completed it at their convenient time.

Google Meet was used to conduct the interviews. The interviews aimed to gather in-depth information about participants' viewpoints and experiences using collaborative learning platforms in science courses. The researchers interviewed the participants using a semi-structured method, allowing them to tailor their questions and the complexity of the responses they received.

2.5 Data Analysis

The collected data were managed in Microsoft Excel and analyzed using the Statistical Package for Social Sciences (SPSS) version 27. Specifically, the extent of the use of collaborative learning platforms and students' satisfaction, attitude, and achievement levels in science courses were all summarized using descriptive statistics. The effect of collaborative learning platforms on student attitudes and achievement in science classes was examined using simple linear regression. Thematic analysis by Braun and Clarke (2006) was also utilized to examine the interview data. This technique created categories based on the similarities and differences between the interview data's patterns and themes. Through this analysis, the researchers were able to discover shared experiences and opportunities using collaborative learning platforms in science classrooms.

2.6 Ethical Considerations

The current investigation was carried out with ethical considerations in mind. Before their involvement in the study, all individuals gave informed consent. Participants

received assurances that they had the freedom to leave the study at any moment without repercussions. Pseudonyms were used throughout the study to protect confidentiality and anonymity, and data were stored safely. The information gathered was used exclusively for the study's objectives; no outside parties were given access. The study was carried out per the research institution's ethical standards and with all relevant laws and regulations.

3. RESULTS

3.1 Use of and Satisfaction toward Science Collaborative Learning Platforms

The extent of the use of collaborative learning platforms in Science is presented in Table 2.

Table 2. Extent of the use of collaborative learning platforms in Science

Platform	Extent of Use (Mean)	Description
Chats	4.69	Always used
Emails	4.48	Always used
Social Media	4.45	Always used
Google Docs	4.23	Always used
Video Conferences	3.96	Often used
Wikis	3.16	Sometimes used
Forums	3.11	Sometimes used
Workshops	2.82	Sometimes used
Phone	2.64	Sometimes used
Podcasts	2.55	Rarely used
Skype	2.10	Rarely used
Overall Extent of Use	*3.47*	*Often used*

Based on Table 2, the BSEd Science students always use chats, emails, social media, and Google Docs because these are the usual avenues for collaboration during remote learning settings, including online learning. In addition, they often use video conferences, as evident in synchronous science sessions. They sometimes use wikis, forums, workshops, and phones due to extra effort and time to explore and navigate these platforms. Podcasts and Skype are rarely used because they are more specialized, requiring technical knowledge to access them. Overall, the students often used collaborative learning platforms (μ=3.47) to conduct online Science activities.

The level of student's satisfaction with using collaborative learning platforms in Science is shown in Table 3.

Table 3. Level of students' satisfaction towards the collaborative learning platforms

Indicators	Mean	Description
The satisfaction that working together can help me gain a deeper understanding of my study.	4.19	Satisfied enough
I have benefitted from interacting with my teammates.	4.18	Satisfied enough
Overall, I am satisfied with my collaborative learning experience in this course.	4.17	Satisfied enough
Interacting with the other members can increase my motivation to learn.	4.14	Satisfied enough
I enjoy the experience of collaborative learning with my teammates.	4.14	Satisfied enough
Collaborative learning in my group was adequate.	4.14	Satisfied enough
I actively exchanged my ideas with group members.	4.03	Satisfied enough
I feel satisfied with my peers' and teachers' interactions within the group.	3.97	Satisfied enough
I like working in collaborative groups with my teammates.	3.96	Satisfied enough
I felt part of a learning community in my group.	3.91	Satisfied enough
Overall Level of Satisfaction	*4.08*	*Satisfied enough*

As presented in Table 3, the students were most satisfied with working with their teammates using collaborative learning platforms. They were also satisfied with their motivation, experience, effectiveness, and active learning when using these collaborative platforms. They were satisfied as they felt they belonged in a community when peers and their teacher interacted. The students were generally satisfied (μ=4.08) with the collaborative learning platforms.

3.2 Science Attitudes and Achievement

The extent of students' science attitudes is presented in Table 4.

Table 4. Extent of students' science attitudes

Indicators	Mean	Description
Cooperative learning helps me to socialize more.	4.31	Very positive
Cooperative learning enhances good working relationships among students.	4.29	Very positive
Cooperative learning enhances class participation.	4.22	Very positive
Group activities make the learning experience easier.	4.22	Very positive
Cooperative learning can improve my attitude toward work.	4.14	Positive
Creativity is facilitated in the group setting.	4.14	Positive
I willingly participate in cooperative learning activities.	4.02	Positive
Our members of the group associate with each other outside of the assigned tasks.	3.98	Positive
During our group work, everyone participates.	3.88	Positive
When I work together, I achieve more than when I work alone.	3.76	Positive
Overall Extent of Science Attitudes	*4.10*	*Positive*

As shown in Table 4, the students have very positive attitudes toward Science because the collaborative learning platforms helped them socialize, work relationships,

participate in class, and have a more effortless learning experience. They also got positive attitudes due to the other effects of the platforms, such as improved working attitude and group setting, participation in the group, and working together as a group. In a capsule, the students have positive attitudes toward Science (μ=4.10).

The achievement of the students in Science is highlighted in Table 5.

Table 4. Extent of students' science attitudes

Level (Percentage)	Mean	Description
Fair, 2.6-3.0 (5%) Good, 2.0-2.5 (28%) Very Good, 1.4-1.9 (59%) Excellent, 1.0-1.4 (8%)	1.85	Very Good

As highlighted in Table 4, most students got a Very Good achievement in Science (59%) and a Very Good mean achievement (μ=1.85).

3.3. Comparison of Use of Collaborative Learning Platforms, Students' Satisfaction, Science Attitudes, and Achievement between Public and Private Institutions

The four measures in the previous sections were subjected to a t-test for independent samples set at 95% confidence intervals. The results of this comparison are showcased in Table 5.

Table 5. Comparison between collaboration, satisfaction, attitudes, and achievement

Variable	Public	Private	Difference	t-value	p-value
Use of a collaborative learning platform	3.88	3.70	0.18	1.030^{ns}	.302
Students' satisfaction	4.09	4.07	0.02	0.167^{ns}	.868
Science attitudes	4.08	4.11	-0.20	-0.215^{ns}	.830
Science achievement	1.79	1.90	-0.11	-1.421^{ns}	.158

Table 5 results indicate no significant differences in the use of collaborative learning platforms (p=.302) between public and private higher education institutions. In addition, the students' satisfaction (p=.868), science attitudes (p=.830), and achievement (p=.158) do not have significant differences between public and private schools. This finding suggests that both institutions have similar extents of using collaborative learning platforms and allied variables such as satisfaction, attitudes, and achievement.

3.4 Effect of the Use of Collaborative Learning Platforms the Students' Science Attitude and Achievement

Three measures were subjected to two simple regression analyses, using collaborative learning platforms as independent variables, while science attitudes and achievement are the two different dependent variables. The results of these analyses are shown in Table 6.

Table 6. Results of simple regression analyses

Variable	B	t-value, p-value
Science Attitude	0.120	1.883^{ns}, .063
Science Achievement	0.009	0.200^{ns}, .842

Table 6 shows that collaborative learning platforms do not significantly affect the students' science attitudes (p=.063) and achievement (p=.842). These results suggest that the said platforms may only sometimes lead to higher levels of attitude and achievement.

3.5 Students' Challenges in the Use of Collaborative Learning Platforms

With all 20 students as participants, 34 formulated meanings, and 54 significant statements were derived. These formulated meanings can be narrowed into three themes.

3.5.1 Unequal Participation

The students said that they experienced a challenge regarding uncooperative group members and unequal contributions from the said members. Other anecdotes include having members as burdens of the group. One participant mentioned, "*Mostly would be the burden of handling almost all the task of my members. It is not about the trust, but most of the times there are members that are irresponsible and undisciplined*" (P10). Another participant said, "*The challenges I encounter during collaborative learning activities are unequal participation within the group and some misbehavior.*" (P20).

This unequal participation could be due to avoidance, other responsibilities, and lack of teamwork, primarily since these collaborative activities were conducted online.

3.5.2 Conflicting Perspectives

Different perspectives can be a challenge among students in collaborative platforms. The participants opined that they sometimes have overlapping ideas, overloading choices, different working styles, and a varied pace. Two participants opened, "*Deciding on the ideas. Everyone has many ideas, which makes it hard to choose which idea would be suitable enough for that specific task*" (P2). "*According to my own experience, difficulties in group work include the reliance on the group by some members; the intricacy of the concepts; mismatched working styles; different individual working speeds; and the discomfort with sharing ideas."* (P11)

As students have diverse ideas and opinions, sometimes conflicting perspectives occur in online collaborative learning platforms.

3.5.3 Lack of Communication and Self-Confidence

As students learn online, there are times that they have difficulties communicating with one another. Some members must answer texts or calls, making collaborative work less effective. Aside from this, they were also afraid and sounded stupid in front of their groupmates; in short, they lacked self-confidence when they faced their peers. A leader participant shared, "*Since I am mostly assigned as a leader, with the current setup, I find it challenging to reach out to my members because not every time is everyone online. So they cannot respond on time whenever I have clarifications or problems.*" (P17). Another participant expressed, "*Well, the challenge that I always encounter is expressing or sharing my ideas with the group because I am afraid to sound stupid in front of other people, but sometimes I still end up saying stupid things anyway.*" (P3).

Students attribute the communication concerns to Internet connectivity issues. They also relate their lack of self-confidence to the fewer interactions they had with their classmates due to the constraints of physical interaction.

3.6 Students' Opportunities on the Use of Collaborative Learning Platforms

With all 20 students as participants, 17 formulated meanings, and 51 significant statements were derived. These formulated meanings can be narrowed into three themes.

3.6.1 Social Skills Development

Although the participants experienced several challenges, they had opportunities to develop different aspects of themselves. Most of them revealed that they improved their social skills through online collaboration, while others enhanced their communication and leadership skills. Two participants mentioned, "*You will know how to socialize and understand the uniqueness of everyone that surrounds you.*" (P16). "*I was able to develop time management and leadership skills. Third, it helped me know how to communicate and use appropriate words.*" (P10).

The participants have enhanced their social skills with online collaborative learning platforms, including communication, leadership, and mentoring.

3.6.2 Higher Order Thinking Skills Development

Some participants might say that they cannot reach their teammates. However, this situation led them to develop higher-order thinking skills as they could attain lacking information, work on parts they were not assigned to, and learn from others. Three participants argued, "*It also generates higher order thinking skills and fills in my information gaps towards the content or subject.*" (P18). "*Allowing me to learn from the group, get the different sources of information, and I have learned in different means.*" (P9). "*The opportunities in collaborative learning have given me is that it provides experiences that develop both good learning skills and social skills.*" (P20).

Higher-order thinking skills include developing critical thinking skills as they work on different viewpoints or perspectives whenever they lack information due to the non-cooperation of their peers.

3.6.3 Values Inculcation

The participants mentioned that they developed knowledge, skills, values, and attitudes. Their collaborations on online platforms make them more open-minded, respectful, and courteous. One participant shared, "*I still tend to get nervous or awkward around different people, but I could say that I have improved.*" (P3). Another participant said, "*I also had the opportunity to share what I can do and offer, which enables me to trust my skills and capabilities.*" (P17).

Collaboration among students can lead to the development of desirable traits like open-mindedness, patience, and even confidence.

4. DISCUSSION

The students often used collaborative learning platforms (μ=3.47) to conduct online Science activities. These online platforms include chats, emails, social media,

Google Docs, and video conferencing, which are frequently used in science education. These platforms enable real-time communication, collaboration, and resource sharing among students who may be geographically dispersed (Coman et al., 2020). These platforms enable asynchronous communication and cooperation, which is advantageous for students from different hometowns who learn remotely. Online collaborative learning systems can also improve student engagement, create students' sense of community, and encourage critical thinking and problem-solving abilities (Ajayi & Ajayi, 2020).

The students were generally satisfied (μ=4.08) with the collaborative learning platforms. Science education students were satisfied because these online learning collaborative platforms offer flexibility, convenience, and chances for active engagement and collaboration. These platforms make it simple for students to communicate and share resources, which can improve their learning opportunities and help them succeed in school (Mahmood, 2021).

Moreover, the students had positive attitudes (μ=4.10) and outstanding achievement in Science (μ=1.85), indicating that students responded positively to their Science subject. This finding could be attributed to the collaborative learning environments that encourage students to participate in their education actively (Qureshi et al., 2021), which can increase their motivation, engagement, and interest in Science (Opona et al., 2022). Aside from this, the interactive learning environments let students work together and connect with their classmates, which can encourage a more profound comprehension of scientific topics and the sharing of ideas and opinions (Quadir et al., 2022). Moreover, collaborative learning environments allow students to get peer assessment, which can help them develop their scientific knowledge and abilities (Männistö et al., 2020). In addition, collaborative learning platforms make access to various resources, including multimedia content, information and communications technology, and online databases, possible (Lebenicnik et al., 2015; Sanchez et al., 2023). These resources can help students learn and improve their performance. Collaborative learning platforms can generate learning environments conducive to student accomplishment and attitudes toward Science.

There was no significant difference in the use of collaborative learning platforms (p=.302), and the students' satisfaction (p=.868), science attitudes (p=.830), and achievement (p=.158) between the public and private universities. One explanation could be that access to technology and internet connectivity is comparable at public and private higher education institutions (Selvanathan et al., 2023), making it easier to use platforms for collaborative learning. Online learning may be subject to equivalent standards and requirements at public and private higher education institutions (Xu & Xu, 2019), resulting in comparable student engagement and satisfaction levels. Additionally, the nature of the subject matter, which may necessitate a high level of collaboration and interaction among students, may be the driving force behind the usage of collaborative learning platforms in Science (Onyema et al., 2019). The similar results of collaborative learning platforms in Science, student satisfaction, attitudes toward Science, and science achievement across public and private higher education institutions may indicate how well these platforms improve students' educational experiences in various institutional contexts.

However, collaborative learning platforms have had no significant effects on the students' science attitudes (p=.063) and achievements (p=.842). The lack of a significant impact of collaborative learning platforms on students' attitudes toward and performance in Science could be attributable to the fact that other factors, such as prior

knowledge, motivation, and engagement, can also have an impact on students' attitudes and performance (Uz Bilgin & Gul, 2020). Not all students may benefit from collaborative learning platforms due to individual differences in learning preferences, talents, and learning methods (Silalahi & Hutauruk, 2020). More research is required to understand better the conditions under which these platforms are most effective and how they can be used in conjunction with other teaching strategies to improve students' attitudes toward and achievement in Science. This instance is proper even though using collaborative learning platforms in Science can benefit students' learning.

The participants encountered challenges as they used the collaborative platforms while they learned online, including unequal participation, conflicting perspectives, and lack of communication and self-confidence. Some group members may dominate the conversation during uneven participation or shoulder a more significant portion of the task. In contrast, others contribute less or less (Struß & Rummel, 2021). Students may become frustrated and disengaged, and the group's work may suffer. Sometimes, conflicting perspectives can cause arguments or make it harder to reach a consensus when students have various viewpoints or methods for completing a work (Vanderheide et al., 2021). Science presents significant difficulties because facts or outcomes may have several legitimate interpretations. Lastly, a lack of communication and self-confidence can also hinder productive collaboration because students may feel awkward sharing their thoughts or cannot do so in a group context (Medaille & Usinger, 2019; Picardal & Sanchez, 2022). To overcome these obstacles, it is vital to carefully plan and facilitate cooperative activities and offer assistance and resources to aid students in gaining the abilities and self-assurance needed to work productively in groups.

Aside from the challenges, the students also encountered learning opportunities using online collaborative platforms, such as social skills development, higher-order thinking skills development, and values inculcation. One such potential is the development of social skills, as students discover how to interact with others successfully, listen intently, and cooperate (Halimah & Sukmayadi, 2019). Additionally, collaborative learning offers chances to build higher-order thinking abilities, including creativity, problem-solving, and critical thinking (Hu et al., 2022). These abilities are crucial in Science, where students must examine data, draw conclusions, and devise experiments. Furthermore, collaborative learning can instill crucial values like accountability, empathy, and respect for others (Luthfiyah et al., 2022). Students can understand many points of view, a sense of shared responsibility, and a supportive learning environment by cooperating with their peers. In general, collaborative learning environments offer students a rich and dynamic setting to develop the abilities, understandings, and moral principles necessary to excel in Science and life.

Based on the discussion above, future research may be conducted to determine the factors that could affect the students' satisfaction and science attitudes through appropriate regression analysis and moderating factors influencing the said variables using the structural equation modeling. Aside from this, comparative studies could be done to test the effectiveness of different online collaborative platforms in specific topics in biology, chemistry, earth science, and physics. Lastly, qualitative studies on the roles of teachers and students and between them and the content and platform could be explored to derive perspectives of the platforms from addressing possible challenges.

5. CONCLUSION

This study sought to ascertain how collaborative learning platforms affected students' attitudes toward Science and their successes, problems, and prospects. The

results of this study show that Science Education students in public and private higher education institutions frequently use and are satisfied with online collaborative learning platforms like chats, emails, social media, and video conferences. The study also found that students' attitudes toward and performance in Science were unaffected significantly by using collaborative learning platforms. This situation indicates that collaborative learning environments present numerous opportunities for students to acquire critical abilities and values, including social skills, higher-order thinking abilities, and inculcation. However, they also pose difficulties like unequal participation, conflicting viewpoints, lack of communication, and low self-confidence. Overall, this study shows how important it is for teachers to carefully examine the use of collaborative learning platforms in science education and give students the assistance and direction they need to overcome any obstacles they may face in this learning environment.

As pedagogical recommendations, the researchers suggest that Science teachers adopt collaborative and individual activities to have a well-balanced approach to learning Science. When using online collaborative platforms, teachers must have open lines for communication so that students ask for guidance and express themselves, promoting active participation while using the platforms. Aside from this, teachers must foster independent learning while they ensure that higher-order thinking skills are applied during learning activities. Ultimately, teachers must have opportunities for professional development to enhance their capabilities as online teachers who foster collaboration, critical thinking, and creativity.

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