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Student Learning Satisfaction and Academic Performance in Philippine Science High School Chemistry: A Prediction Model Building Study for Online Learning

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Abstract

Learning satisfaction is a key indicator of enriching student learning whether it is face-to-face or online mode of delivery. Learning has shifted more to remote online learning due to the Covid-19 pandemic. This study aimed to identify the determinants of Student Learning Satisfaction (SLS) in online learning and develop a model that represented the relationship of the determinants to SLS. The study explored both internal and external determinants hypothesised to influence SLS among 169 students in grades 9-12 taking Chemistry at the Philippine Science High School Cordillera Administrative Region Campus (PSHS CARC). The internal factors included gender, academic self-concept (ASC), academic motivation (AM), interest to learn (IL), and mental well-being (MW), while the external factors comprised teacher-related indicators (Teacher), assessment-related indicators (Assessment), learning guide-related indicators (LG) and Knowledge Hub-related indicators (KHub). The study utilised Structural Equation Modelling (SEM) with SmartPLS software to develop the SLS model and Academic Performance (AP) model. Both online learning platforms used by PSHS CARC, the LG, and KHub, were found to influence SLS. The external determinants (LG, KHub, Teacher, Assessment) dominated the SLS models while internal determinants (ASC, AM, IL, MW) dominated the AP model for the PSHS CARC Chemistry students. The external determinants influenced the student's learning satisfaction while the internal determinants influenced the AP of the Chemistry students. Assessment indirectly affected SLS. Another finding was that gender, LG, and ASC directly influenced AP. The results validate that online learning tools (LG and KHub) were crucial determinants in ensuring learning satisfaction and academic success in the online learning of PSHS CARC Chemistry students. The models (SLS and AP) can be utilised to evaluate and enhance the quality of online learning and the development of effective online learning strategies and policies especially regarding the use of online tools like LG and KHub.

Introduction

The Covid-19 pandemic has rendered online learning as the default mode of learning. Before the pandemic, online learning was considered merely an alternative or a complementary learning mode to the traditional classroom face-to-face learning. The issue of student satisfaction is a crucial factor in determining the success of learning for educational institutions and educators to guarantee that

they are meeting the needs of students and delivering satisfying learning experiences in online or face-to-face modes. The need to study and determine the factors that contributed to student satisfaction in online learning was important for assessing the effectiveness of online learning strategies. The concept of learning satisfaction captured the attention of educational researchers after the implementation of online learning. Learning satisfaction is the feelings and attitudes of the learner which reflect the level of fulfilment during the learning processes (She et al., 2021). Learning satisfaction focuses on the level of learner's fulfilment in the learning process, and more importantly on the quality of the learner's output. The new challenges of maintaining quality education, including learning satisfaction and determining the factors that affected the quality of education, were the most pressing issues during the implementation of online learning. This study was conducted at the Philippine Science High School Cordillera Administrative Region Campus (PSHS CARC) during the school year 2021-2022. 169 students from grade 9 to grade 12 enrolled in Chemistry courses participated in this study. The challenge presented to the PSHS administration is on how to maintain the high standard quality of graduates despite the challenges in the implementation of online learning. Hence, the important element of this study is building a model that best represents the learning satisfaction and academic performance of PSHS CARC Chemistry learners with the aid of Structural Equation Modelling (SEM). SEM combines two statistical methods: confirmatory factor analysis and path analysis. This study aims to assess the influence of identified external and internal determinants of Student Learning Satisfaction (SLS) and Academic Performance (AP). This research was undertaken to come up with SLS models and AP models which best represent the PSHS Chemistry learners in the context of online learning.

Methodology

The participants were requested to submit accomplished assent/consent forms before implementing the survey. Those who submitted the forms were asked to answer a series of Five-point Likert scale survey questionnaires on student satisfaction, academic self-concept, academic motivation scale, interest to learn questionnaires, and mental well-being scale. The modified student satisfaction survey by Fieger (2012) was employed to gather data on PSHS students' satisfaction levels in relation to learning determinants such as teachers, assessments, learning guides, and KHub. To explore students' attitudes, feelings, and thoughts about themselves in relation to learning, the Academic Self-concept survey questionnaire originally developed by Raynor & White (2013) was modified. The Academic Motivation survey questionnaire, adapted from Ansari et al. (2021), was used to measure students' motivation levels specifically in the context of learning chemistry. To evaluate students' interest in learning chemistry, the researchers created an Interest to Learn survey based on a sample derived from the Student Interest and Learning Style Survey for Social Studies. To assess students' mental well-being, the researchers employed the Mental Well-being survey questionnaire, which was adapted from The Warwick-Edinburgh Mental Well-being Scale (WEMWBS) and the literature by Tennant et al. (2007).

The instruments, including the questionnaires, underwent content validation by experts to ensure their relevance and effectiveness. Quantitative statistical computations were performed using a spreadsheet and a specific statistical software called SMARTPLS (SEM-PLS). This combination of tools enabled the researchers to accurately analyse the data, including descriptive statistics, correlation analyses, regression analyses, and structural equation modelling. SmartPLS is a software with a graphical user interface for variance-based Structural Equation Modelling (SEM) using

the Partial Least Squares (PLS) path modelling method. It is a software used when the analysis is concerned with testing a theoretical framework from a prediction perspective and in building a model relationship. Using SmartPLS, path models with latent variables (in this study the latent variables are the determinants) were estimated or determined whether there was a significant influence of the determinants on learning satisfaction using the PLS-SEM algorithm. The software computes standard results assessment criteria (e.g., for the formative measurement models, the structural model, and the goodness of fit) and it supports additional statistical analyses such as the preliminary testing of the validity and reliability of the questionnaires based on the responses.

The Bootstrapping PLS feature of the SmartPLS software calculates statistical p-values that were used to determine if the correlation between two variables was significant. Significant paths are kept while non-significant paths are removed until the structural model for learning satisfaction is completed. All possible connections among the variables are considered. The SmartPLS uses multivariate analysis. The multivariate analysis takes into consideration as many factors as possible and determines important relationships and structures among multivariate data. All correlation tests were two-tailed and p-values less than 0.05 were considered statistically significant. Data analysis was automatically done by the SmartPLS once the data was encoded into the software.

Results and Discussion

The External Determinants

Teacher Satisfaction

Teachers at PSHS were not only expected to possess deep subject knowledge but also to maintain a high level of student satisfaction on their teaching performance. The result of the teacher satisfaction survey clearly demonstrated the high level of student satisfaction on their teacher performance which included the teacher's knowledge, philosophy of teaching, attitude, and teaching performance as observed through their conduct of learning and interactions with students. The students across all grade levels were highly satisfied with their teachers' contributions to their learning experiences. The respondents in this study emphasised the importance of the teacher's classroom management and attitude, as they significantly influenced students' satisfaction with their Chemistry learning experiences.

Assessment Satisfaction

Assessments such as exams and quizzes have long been recognised as a significant source of stress and anxiety in the academic lives of students. However, it is important to acknowledge that assessments play a crucial role in evaluating students' learning and understanding. Consequently, it is imperative for students to find satisfaction in the assessment process. The student respondents reported relatively high levels of satisfaction with their assessments. Among the various aspects of assessment, the level of difficulty criterion received the lowest satisfaction rating across all grade levels. This finding is not surprising considering that Chemistry is widely regarded as one of the most challenging subjects. Assessments in Chemistry often require students to demonstrate not only knowledge but also their analytical and problem-solving skills. Hence, the complexity of these assessments contributed to the lower satisfaction ratings in terms of difficulty.

Learning Guides (LGs) Satisfaction

In the absence of a physical classroom and face-to-face interaction with teachers, PSHS-CARC implemented Learning Guides (LGs) as a solution. LGs served as asynchronous learning materials, allowing students to learn at their own pace and convenience. However, the satisfaction ratings revealed some areas that need improvement. Students' expectations included more visual elements and a user-

friendly approach in the design of LGs. It appears that students may prefer more visual illustrations and less technical discussions in their LGs to enhance their learning experience.

KHub Satisfaction

KHub was implemented by the PSHS system as a learning management system to complement the learning guide in the online learning experience of the students. The features of KHub play a crucial role in assisting students with their online learning, which can ultimately lead to either satisfaction or dissatisfaction among students. Overall, the respondents reported relatively high levels of satisfaction on the use of the KHub. The students find KHub accessible and easy to use. However, students seem to be relatively unsatisfied with the notification features and response time of KHub.

The Internal Determinants

Academic Self-Concept (ASC)

How the students perceive themselves in their learning activities is a very important aspect of how a student would learn. Learning starts with a correct mindset. A positive self-concept will result in better learning, whereas a negative self-concept will spell failure in learning even before the learning process is started. The Academic self-concept survey result indicated that the PSHS student respondents exude optimism in their academic self-concept. Among those with high ratings across all grade levels are ASC item 1 (If I try hard enough, I will be able to get good grades) and ASC item 26 (I would like to be a better student than I am now). Meanwhile, ASC item 24 (I am good at scheduling my time) and ASC item 35 (I have a very good study habit) had relatively low ratings. In other words, the students do not find themselves having the self-discipline to schedule their study time and have good study habits.

Academic Motivation (AM)

Academic motivation encompasses the driving factors behind behaviours that impact academic performance and achievement. These factors include the level of effort students invest, their ability to manage their workload effectively, the pursuits they choose to engage in, and their perseverance in the face of challenges (Usher & Morris, 2012). While all grade levels are motivated by earning high grades in Chemistry, they seem to be "demotivated" by the problem-solving requirements of Chemistry courses. In other words, their difficulty in solving problems decreases their academic motivation toward Chemistry. PSHS students have been observed to be competitive in their academics in general but maybe not in Chemistry as the result of this survey shows. Another implication is a demotivation of the students to have a career in Chemistry. The students do not find motivation in having a career in Chemistry and hence the low motivation to learn.

Interest to Learn (IL)

Interest in learning is a personal inclination and desire that promotes active engagement in the learning process. When individuals are genuinely interested in a subject, they exhibit enthusiasm, curiosity, and a willingness to invest time and effort to expand their understanding. This intrinsic motivation not only enhances the learning experience but also improves knowledge retention and application. At all grade levels, students displayed enthusiasm for acquiring new knowledge in Chemistry, demonstrating a positive attitude for learning. Nevertheless, the data also uncovered areas where students showed less inclination: reading in advance before a Chemistry topic is discussed in class and engaging in research activities related to Chemistry. These aspects received the lowest ratings in the survey. The student ratings across all grade levels indicate a relatively low level of interest in learning Chemistry.

Mental Well-being (MW)

Enhancing the mental well-being of learners is crucial, especially in the context of the pandemic, where students face unique challenges in their learning. The mental well-being of learners refers to their ability to cope with the demands of learning under pandemic conditions and their capacity to concentrate on their studies. The study by Ranadewa (2021) showed that mental well-being affects learners' satisfaction. The mean score of the students on mental well-being survey question shows an alarming signal that the students' mental well-being should be a concern while they are in the online learning process. The students' own self-rating on their ability to think clearly, dealwith problems, and feelng confident are relatively low.

Academic Performance (AP)

Academic performance in online learning refers to how well students perform academically within virtual educational settings. It encompasses achievements, grades, and overall learning outcomes. The student's AP is solely dependent on their final Chemistry course grades. The Chemistry grades of each student respondent were recorded confidentially. Table 1 summarises the average grades per grade level of the student-respondents. The grading system is as follows: 1.0; 1.25; 1.50; 1.75; 2.0; 2.25; 2.50; 2.75; and 3.0, with 1.0 as the highest grade.

Table 1. Average Chemistry Grade per grade level.

GRADE LEVEL	Average Chemistry Grade		
	MALE	FEMALE	ALL
Grade9	1.72	1.97	1.85
Grade10	1.57	1.30	1.43
Grade11	1.25	1.17	1.20
Grade12	1.20	1.32	1.29

The SLS Models

Figure 1 shows the SLS Model for each grade level to easily see direct and first-degree indirect determinants to the SLS for each Grade level resulting from the procedure described in the section Methods with the SmartPLS.
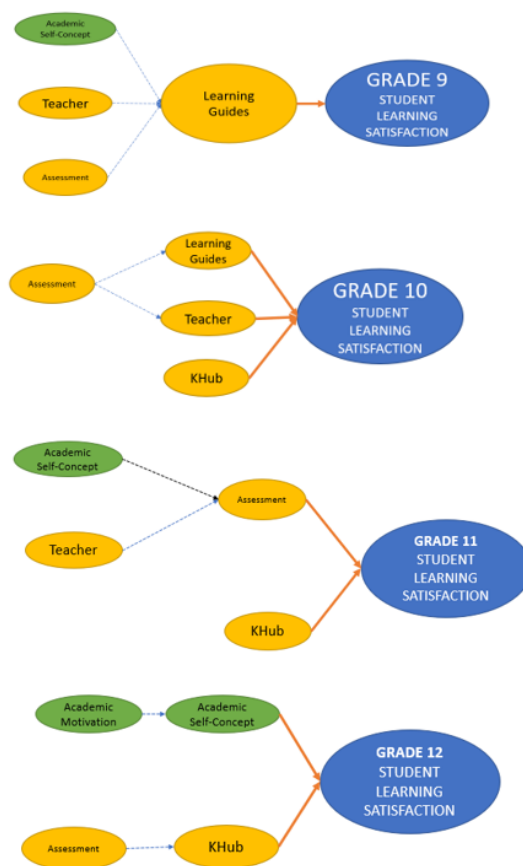

Figure 1. SLS Model for each Grade Level showing direct and indirect determinants.

Interpretation of resulting SLS model per grade level are as follows:

1. LG showed direct significance to the SLS in Chemistry for Grade 9 and 10. This can be explained by the high reliance of the younger students on the LG during the academic year 2021-2022. As the students were expected to be independent learners, the interaction between students and teachers became less frequent. This was due to the fact that the LGs had become the main source of "personal" contact between the students and teachers which instructions on what topics to study as well as activities and problems to solve are stated and explained. LGs became the manual for students in their learning process, particularly for the younger learners. PSHS-CARC Chemistry students in all grade levels agreed that clarity of the directions in the LG along with the completeness of the LG followed by creativity we're the most

important. These factors or features should have been taken advantage of designing the LG aimed at the learning satisfaction of the students. On the contrary, based on the students' responses, the LG became a negative determinant to learning satisfaction if they were too lengthy in content and the time allotted to complete the modules was insufficient.

2. Assessment showed indirect significance to the SLS of the students in Chemistry for all grade levels. Interestingly, Assessment was significantly related to LG and KHub. LGs gave directions to the students on which assessment activities to do. Hence, it is not a surprise that LG and assessment were closely and significantly related to each other. The KHub was also used for online assessment activities. Assessments were found to influence learning satisfaction if timely feedback was given. Based on the students' qualitative responses, the students found the time allotted to complete the assessment, the type of assessment and the number of assessments required in the Chemistry course reasonable. The students appreciated the flexibility of setting deadlines for the assessments. However, the Grade 9 students complained about the level of difficulty of assessments, the Grade 10 students complained about unclear instructions in assessments, the Grade 11 students complained about inconsistent intervals of giving assessments, and the Grade 12 complained about the assessment outputs that replace quizzes and exams such as PowerPoint and video presentations, infographics, and other creative outputs.

3. The Knowledge Hub (KHub), an online learning support system, was directly significant to Self-Regulated Learning Strategies for all grade levels except Grade 9. Learning Management Systems (LMS), such as KHub, were essential for online learning. However, for KHub to enhance learning satisfaction, it needed to be developed to ensure ease of use, usefulness, and navigation. Qualitative feedback highlighted KHub's ease of access and navigation across various digital devices. Dissatisfaction arose mainly from internet speed and stability issues, causing erratic notifications and hindering learning. This result aligns with Alenezi's (2018) study, which identified barriers to LMS adoption such as limited internet access and infrastructure. Despite these challenges, students using KHub for online learning at PSHS reported a level of learning satisfaction.

4. The Teacher Determinant had different effects on each grade level. Grade 10 students viewed their Teacher Satisfaction as directly related to their learning satisfaction, while Grade 9 and 11 students showed their learning satisfaction to be indirectly related to their teacher satisfaction. The Grade 12 students did not perceive teacher satisfaction influencing their learning satisfaction. This may have been attributed to the fact that higher grade level PSHS students were taught to be more independent learners. Assessments were found to influence learning satisfaction if timely feedback was given (Dziuban et al. 2015; Bahati et al. 2019).

PSHS teachers are experts and masters of the courses they teach. The PSHS Chemistry curriculum is at the same level as those taught in university-level courses. Based on the students' responses, while the students did not complain about the requirements demanded of the courses, they appealed for consideration of teachers' expectation that they should easily understand the lesson taught and that they should strictly follow deadlines of submissions of the course regardless of the circumstances. The students seemed to appeal more time for them to absorb the lesson and enough reasonable time to complete requirements. The late return of their outputs and feedback on their completed activities was a source of teacher dissatisfaction for the Grade 9 Chemistry learners.

5. Among the internal determinants, ASC showed a direct effect on SLS for Grade 12

students and indirect effect on SLS for Grade 9 and 11 students. The factors IL and MW did not show any influence on the learning satisfaction of students. AM only indirectly affected the learning satisfaction of Grade 12 students. However, the relatively low ratings on these internal factors signalled that possible intervention might be needed for the PSHS students on these determinants. It is interesting to note that the ASC is significantly connected to the LG. One possible explanation might be that the LGs were meant for self-study. The study by Hassan et al. (2021) showed that positive academic self-perceptions were found to strongly influence satisfaction in the course. Hence, a high self-perception of the student's academic self-concept that they can learn on their own with minimum supervision through the LG was important.

The Academic Performance (AP) Model

Figure 2 showed the final AP Model to easily see direct and indirect determinants to the academic performance/grade of the Chemistry students.
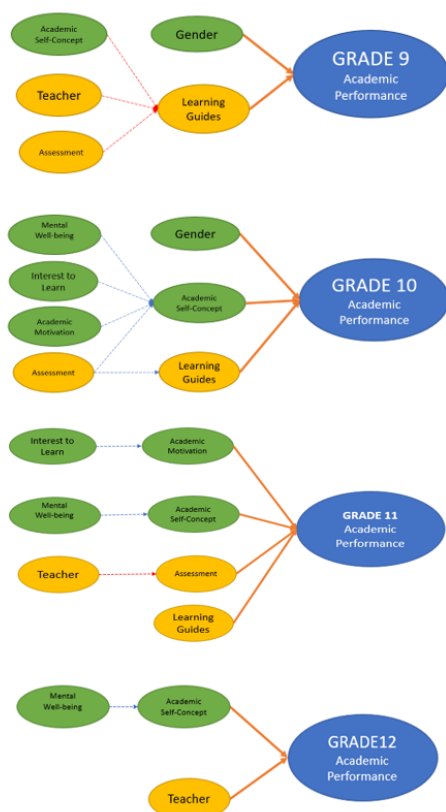
The resulting AP Model per grade level is summarised as follows:

1. Gender appeared to be a factor in the AP of Grade 9 and Grade 10 students but not for Grade 11 and Grade 12. Based on the results, Grade 10 male learners have higher Chemistry grades than their female counterparts. Meanwhile, Female PSHS-CARC Chemistry Grade 9 students have higher grades in Chemistry than the male Grade 9 students. However, the contrasting results for Grades 9 and 10 mean that it is not conclusive to infer which gender has a better AP in Chemistry. The study of Yu and Deng (2022) which investigated gender differences in e-learning outcomes globally, focusing on self-efficacy, satisfaction, motivation, attitude, and performance, concluded that, in general, there are no significant gender differences in e-learning outcomes across most countries.

2. The external factors (Teacher, Assessment, and LG) have varying effects on AP at different grade levels.

Teacher satisfaction directly influenced the Grade 12 AP and indirectly influenced the Grade 10 and 11 students. The findings of this study suggest that teacher communication orientations and student communication preferences can impact student performance. Effective communication between teachers and students is therefore essential for fostering better academic outcomes.

KHub does not show any effect on the student's AP or grades. KHub is not a significant determinant of the student's academic performance/grade for all grade levels.

3. The internal factors (ASC, AM, IL, and MW) also showed varying effects on the academic performance of the Chemistry learners.

ASC showed direct significant effect on the AP for all grade levels except Grade 9.

This means that a high ASC is an important factor for the students to have higher academic performance or grades in Chemistry. Zhan and Mei (2013) reported that both ASC and social presence significantly impact students' learning achievement and satisfaction, However, the general average rating for ASC of the PSHS-CARC students is relatively low compared to the other internal determinants. There may be a need in helping the students improve their ASC. MW, IL, and AM have an indirect effect on the AP of Grade 10 students. However, AM, IL, and MW do not show a significant effect on Grade 9 AP. For the Grade 11 and 12 learners, MW shows an indirectly significant effect on AP. These results collectively reveal that mental well-being plays a significant and often underestimated role in determining the academic outcomes of Grade 11 and 12 students. The emotional state of students directly influences their attitudes towards learning and ultimately impacts their academic performance. Furthermore, the prevalence of heightened stress levels further supports the notion that MW indirectly affects academic success in a positive way.

While the SLS model is dominated by external determinants (LG, KHub, Teacher, and Assessment), the AP Model is dominated by internal determinants (ASC. AM. IL and MW). This means that the SLS is influenced by external factors and the AP of the Chemistry students is affected by internal factors.

Conclusion

The PSHS CARC Chemistry learners are found to be satisfied with all the external determinants: Teacher, Assessment, LG and KHub. The two remote learning tools had the lowest ratings. However, it is interesting to note that both LG and KHub have a significant influence on the learning satisfaction of the PSHS CARC Chemistry students.

The PSHS CARC Chemistry learners have relatively low ratings on their internal determinants: ASC, AM, IL, and MW. While they have a relatively low assessment of themselves as learners, they appear to perform well as evidenced by their high Chemistry grades. The results indicate that PSHS CARC Chemistry students can cope and perform academically well despite relatively low perceptions of their internal (mental and psychological) aspects.

On the SLS Model

The result of the study showed indirect relation between SLS and academic performance. SLS and academic performance are indirectly related through one determinant, the LG. This means that specifically for the PSHS education system, student satisfaction, and academic performance are entirely separate matters.

In general, internal determinants have no direct influence on the SLS. This means that the students get their learning satisfaction from the external determinants. SLS is derived directly from LG and KHub and indirectly through Teacher and Assessment. In other words, external determinants (LG, KHub, Teacher, Assessment) dominate the model. Only one internal determinant, academic self-concept, is indirectly related to SLS.

External and internal determinants are independent of each other. Internal determinants do not influence the external determinants. While it is expected that students who get higher grades tend to have better learning satisfaction, the result of the PSHS Chemistry learners' perceptions showed a different picture. Their goal of attaining high grades is not tied directly to their learning satisfaction.

On the relationship of Student Learning Satisfaction and their Academic Performance

For the young learners (Grade 9 and Grade 10), the result of the study showed that the learning satisfaction of the students does not directly influence the AP. In addition, for these young Chemistry learners, this study

showed that the AP is indirectly related to the learning satisfaction through the LG determinant. For the older Grade 11 and 12 learners, there was no significant connection between the learning satisfaction and their academic performance.

On the Academic Performance Model

Academic Performance is important for PSHS because it is an indicator of the student's academic achievement rather than their learning satisfaction. A stark contrast to the SLS model, which is dominated by external determinants, the AP Model is clearly dominated by internal determinants. The AP Model highlights the lack of emphasis on SLS. It confirms that the focus of the students is primarily on achieving high grades rather than valuing their learning experience. While learning satisfaction and academic performance are distinct objectives for PSHS Chemistry students, it appears that the students prioritise the latter over the former.

The Student Learning Satisfaction (SLS) Model and Academic Performance (AP) Model as Predictive Models for Online Learning

In this study, the developed SLS and AP models can be used as predictive models of student behaviour and their Chemistry grades, respectively. The SLS Model can be used to predict the likelihood that the students will enjoy and find satisfaction in learning the lessons in a difficult subject like Chemistry. The AP Model can be used to predict the likelihood of students getting a high grade in their Chemistry subject. Furthermore, the SLS and AP Models as prediction models for online learning can help educators and administrators to provide targeted support to students, leading to improved outcomes and success in online learning environments.

The AP model predicts that students with high ASC would have higher grades. Also, from the AP model, ASC is influenced by the student's perception of their mental well-being, interest to learn the subject, and academic motivation. In other words, high MW, IL, and AM lead to high ASC which in turn leads to a higher grade in Chemistry. The AP model also indicated that the LG predicts the Chemistry grade, which is expected because all assessment and grading requirements are incorporated in the LG.

In summary, one of the important results of this study was that both online learning platforms used by PSHS CARC, the LG, and KHub, were found to be effective tools for online SLS. PSHS CARC may need to improve more on these two determinants towards more positive learning satisfaction experiences for their Chemistry learners. This result (especially for LG) is further reinforced by the fact that learning satisfaction and academic performance are indirectly related to each other through LG. This means that the LG used by PSHS CARC was an effective tool for their online mode of learning. PSHS CARC must take advantage of the use of the LG for the students to enjoy independent online learning because learning satisfaction translates to better academic performance for their Chemistry learners.

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