

Development of an Online Self-Learning Module in Physical Science Through the Addie Model

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Abstract:

The undertaking is about developing an online Self-Learning Module (SLM) in physical science that may be used in the conduct of physical science classes in a special term program at the University of Santo Tomas – Senior High School. This is to make the special term class even more systematized, engaging, stand-alone, organized, and accessible to the students that meet all the standards of DepEd’s necessary competencies. The study employed the stages of descriptive developmental research anchored with the appropriate phases of the ADDIE model. Findings from the study revealed that evaluators strongly agreed that the developed online SLM in physical science showed a very high extent of manifestation in criteria such as specific objectives, content, the language used, appropriateness and novelty, and evaluation activities. These findings implied that the online SLM in physical science for the test-retest showed high-reliability results.

KEYWORDS: ADDIE Model, Assessment, Learning Management System, Self-Learning Module, Synchronous, and Asynchronous Classes

I. INTRODUCTION

In response to maintaining and uplifting the quality of education in the Philippines in complement to the “new normal” setup, the Department of Education (DepEd) had decided to take into consideration those institutions which would be operating in the uncommon pure online classes with the decongested curriculum. DepEd compressed the learning targets into the most essential ones known as the Most Essential Learning Competencies (MELCS). The MELCS have to be met in a full-online setup through synchronous and asynchronous meetings. Synchronous sessions mean schedules are used in real-time, requiring participants and instructors to meet virtually at the same time from different places. Asynchronous sessions on the other note mean self-paced, and therefore participants could use provided asynchronous learning elements such as online audio, video recording, simulation activities, and discussion forums, at the time and place of their choosing.

With all these things in mind and with the idea of sustainably instilling quality education to all types of learners in the UST-SHS, the researcher had come up to develop a timely instructional material specifically an online SLM that caters to the students’ needs of all types and meets the MELCS during the conduct of a short special term program.

Developing an online instructional material was a way to justify the researcher’s background as an SLM author of physical science and earth science textbooks in C&E Publishing Inc., an author of a physical science e-book in Scuola Bookstore, and the experiences encountered during the last special term program in UST-SHS physical science area. In reference, the researcher’s experience as a special term teacher for physical science didn’t quite go well with the expectations set at the start due to certain limitations that include a month or less duration, no concrete plans established as to what part of the MELCS were needed to accomplish, lesson

design, sync and async interplay, and the like. Thus, with the help of the developed online SLM for physical science, the conduct of special terms would become more meaningful and achievable in terms of time management, self-pacing of the lessons, and attainable quality assessments.

Literature Review

Teachers' technological skills around the entire globe were truly put to the test in the midst of 2020 when the COVID-19 pandemic caused schools to stop their usual operations and switch to a kind of remote instruction. As opposed to regular online instruction, which is based on planned course designs created beforehand, emergency remote teaching (ERT) was mostly used as a method of online teaching which evolves as a response to a phenomenon more likely of an emergency crisis (Hodges et al. 2020).

In the study conducted by Kramer (2021), a mixed method of research was used to determine the instructors' perceptions of the opportunities and challenges of integrating technology in crisis-prompted online instruction in the times of COVID-19. In terms of challenges, the findings revealed that most participants did not have prior encounters and experience teaching online, lack of physical proximity changed the class dynamics, time-consuming preparation because of the virtual setup, and students did not engage as much as they were in the face-to-face setup.

Mishra et al., (2021) researched the trends in online distance learning during the COVID-19 pandemic. Research findings revealed that emergency remote teaching is a breakthrough to portray online distance learning. However, it also encompasses concerns/issues about teaching and learning with an emphasis on technology usage, assessments' implementation, teachers' capabilities, and institutional preparedness.

Gutierrez (2022) outlined a lesson in plate tectonics using the intertwining of the 5E learning cycle (engage, explore, explain, expand, and evaluate) and the 5R instructional model (replace, repeat, reveal, reload, and reposition). She found out that the *replace and explore and engage* intertwining, the purpose yielded to "Use student's

background and experiences to present ways of thinking about and using language in the science classroom.

Bahtaji (2021) investigated the role of math and science exposure on the effect of the 5E instructional model in physics conceptions. He found out that the 5E instructional model and previous learning experiences provided a lot of conceptual learning for the learners in Newtonian mechanics. He concluded that the 5E instructional model effectivity can be really maximized and accomplished if the knowledge and skills necessary to learn concepts were properly established from the previous learning experiences.

An online module was designed by Kaliyadan et al. (2020) to completely adapt to all the changes during this COVID-19 pandemic. The developed online teaching module for undergraduate medical students was aligned with the existing course. The module has student manuals, PowerPoint presentations, reference videos, and assessments uploaded on their currently used LMS platform. The majority of the student respondents agreed that the module covered the entire content of the course adequately. Faculty members and the majority of student respondents were also satisfied with the technicality of the devised module.

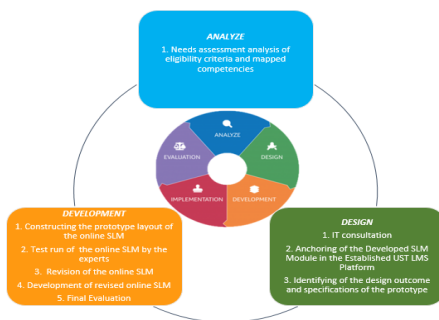
Yazon (2018) validated a module in the assessment of students' learning to determine its effectiveness through pre-test and post-test scores gathered from the student respondents. The modified questionnaire checklist was used in validating the said module which was in connection with the standard's specific objectives, content, language used, and evaluation activities. Findings revealed that the test items covered the important competencies in which pre-test gained below-average results and post-test gained above-average results. It was also found out the pre-test and post-test mean scores were statistically significant. Therefore, the module was statistically proven to be effective as a tool in facilitating the learning process.

Synthesis

Online SLM is a kind of instructional tool that can be used to elevate students' engagement, upskill performance, integrate previously learned information into the most recent one, and sustain knowledge acquisition throughout. An SLM may be used in a particular course, semester, grading period, or discipline. As the COVID-19 pandemic started in the summer of 2020, all schools transitioned quickly to remote teaching having a synchronous schedule of virtual meetings and asynchronous self-paced activities. Nevertheless, all the collated pieces of literature agreed that having online instructional material that suits well the platform used by a particular institution, especially in the field of science can at least compensate for the laboratories that cannot be done virtually but through the development of online modules, 3-D simulations, and gamified activities, and virtual realities otherwise. It also provides a kind of quality education equivalent to what's usually done in the face-to-face modality in terms of lectures, assessments, resources, and the like.

Conceptual Framework

After scrutiny of the details, the researcher decided to use the Analysis, Design, Development, Implementation, Implementation, and Evaluation (ADDIE) Model which was a generic process traditionally used by instructional designers and training developers that utilized the 5 phases in building effective, dynamic and flexible training and performance tools (Culatta, 2021).



Conceptual Framework

The researcher's firsthand experiences as a team leader of the Physical Science department as well as during the summer class in a short time frame were used as major bases in the formulation

of a thesis proposal and so to cater to and meet the students' needs and competencies effectively. Also, the researcher had already a background in two of the Philippines' prominent publishing houses as a content developer/writer of self-learning module textbooks in earth science and physical science (C&E Publishing Inc.) and physical science e-book/textbook (Scuola Publishing House) so developing one had never been a new thing for him.

In the analysis stage, the needs assessment was deployed to faculty belonging to the same department (physical science) to gather the eligibility criteria and justify the need to have an effective and efficient SLM as a walkthrough in the conduct of a short special-term class whenever possible. The design phase of the pursuit focused on the structuring of the online SLM module so it will be compatible with the University of Santo Tomas' current LMS platform – Blackboard through consultation with an IT or a programming expert. This was also the phase where the design outcome (format) and specifications of the prototype built were identified which were all based on the needs assessment analysis result. Afterward, the development part commenced the construction of the prototype online SLM based on the design phase of the study so that the overall layout and function suit well to students of all types and needs. Then, it will be tested and retested after incorporating the revisions and suggestions on the prototype online SLM respectively by the evaluators.

Research Questions

1. What eligibility criteria should be included in the development of an online SLM based on the needs assessment analysis?
2. How an online SLM in physical science is designed based on needs assessment analysis results?
3. How an online SLM in physical science is developed based on test (before) and retest (after) feedback and comment results?
4. How reliable is the online SLM in physical science in terms of the development phase based on test-retest results?

5. Is there a significant difference in the development of the test and retest results on the set criteria of the online SLM in physical science in terms of:
 - a. Specific objectives;
 - b. Content;
 - c. Language used;
 - d. Appropriateness and novelty; and
 - e. Evaluation activities?

II. METHODOLOGY

Research Design

A descriptive developmental type of research was used in the development of online SLM in physical science summer class which describes what is mostly non-obtrusive. It aims to accurately and systematically describe a population, situation, or phenomenon in which it answers *what, where, when, and how* questions, but not *why* questions (Ethridge, 2004). Aligning the research design to its intended purpose, the ADDIE model was used as the standard framework to identify protocols applicable only to the study’s limitations and parameters. Hence, descriptive developmental research dictates that a researcher is performing instructional design, development, or evaluation activities, and studying the underlying processes involved at the same time (Richey, 1994).

As descriptive developmental research played an important role in the usage of the ADDIE model, below is the intertwined relationship between the stages of descriptive developmental research and the ADDIE model.

Descriptive Developmental Research and ADDIE Model Relationship

Descriptive Developmental Research	ADDIE Model
In type 1 descriptive developmental research, the developed product is always analyzed, described, and evaluated (Buch, 1987). The first stage of type 1 descriptive developmental research is reporting and analyzing the data obtained at the start in which the rationale for doing the pursuit is identified and stated clearly.	The analysis phase is also known as the “goal-setting” stage for it identifies the background, intent, methods, targets, and objectives of the educational program to be done.
Conducting a comprehensive	The design phase identifies the

design is the stage where the layout as well as the other important details of the program or product will be done based on the analyzed and reported data.	tools to be used in designing the instructional technology and selecting the specifications before the development of the prototype based on the needs assessment analysis phase.
Development of the project proceeds right after the comprehensive design is achieved. In this stage, the analysis and reporting must be warranted properly in order to determine the instrument’s reliability and validity (Richey, 1994).	The development phase starts with the construction of the prototype educational program or instructional technology based on the gathered information from the design phase.
	The implementation stage reflects modification in the developed prototype educational program to ensure that maximum effectiveness and optimum satisfaction are achieved.
Sub-studies may also include product formative and summative evaluation for follow-up of post-instruction, so best results are obtained.	Evaluation is the last stage of the ADDIE model where feedback is assessed and the incorporation of feedback is subjected to a meticulous final test by reporting the final results obtained (Kurt, 2018).

Sampling Method

The purposive sampling method determines the target members of the population who will be involved in the study and relies so much on the researcher’s way of judging and choosing the qualified members of the population to participate in a particular study (Black, 2010). Further, the rationale for the selection of the purposive sampling method was that it can give the researcher valuable outcome results in no time.

Respondents of the Study

As the purposive sampling method was used in getting the set of evaluators, this included the set of professional educators in the fields of science such as ten (10) teachers from the University of Santo Tomas and the University of the Philippines and one (1) teacher from a private school. The set of professionals was chosen based on their background in handling sciences, years in the teaching career, exposure to full-online teaching modality, and educational qualifications.

Instrumentation (Questionnaire)

Research instrument has undergone several important phases which are hereby elaborated below.

Phase I (Adaptation of the Questionnaire): The modified questionnaire checklist used in the study of Yazon (2018) which was acknowledged by the International Journal of Science and Research (IJSR) with the ISSN number 2319-7064 was adopted by the researcher with the criteria such as specific objectives, content, the language used, and evaluation activities. The additional criterion of “appropriateness and novelty” was added to Yazon’s which measured how the developed online SLM anchored well with the Blackboard LMS of the University of Santo Tomas, how such design and layout suit well with the student’s needs, and how accessible and timely it was during the COVID-19 pandemic.

Phase II (Validation of the Questionnaire): The adopted questionnaire was content and construct validated by the researcher’s adviser, one associate professor from the Polytechnic University of the Philippines, and three senior high school teachers from the University of Santo Tomas. Once their comments and suggestions had been made, the revised and finalized questionnaire was disseminated to the evaluators together with the developed digital Self-Learning Module (SLM) in physical science.

Data Management

Needs Assessment Results Analysis – The needs assessment results were the very cornerstone of why this pursuit had to be done in the very first place and how the product had to be made accordingly. After getting evaluated by the experts on the need to have an online SLM in physical science during the conduct of the special term program in the University of Santo Tomas-Senior High School department, the results were analyzed by the researcher himself and his adviser so the overall layout, design, function, and appropriateness to the learners’ needs were carefully constructed.

Instrument to be used –The first part of the adopted questionnaire asked for the validator’s profile in terms of email, name, affiliation, a

subject he/she handles, and years of teaching career. The second part tackled the criteria that have to be met by the developed online SLM in terms of specific objectives, content, the language used, appropriateness and novelty, and evaluation activities. The last part covered their comments and suggestions for the improvement of the online SLM in physical science.

Designing of the Online SLM Module –The researcher consulted the insights and perspectives of his adviser, former and current students, and IT expert on its accessibility, readability, formatting, manageability, flexibility, and organization before a final one was perfectly structured.

Development of the Online SLM – The developed online SLM was perfectly compatible with the UST-SHS Blackboard Learning Management System (LMS) platform. The mapped competencies included in the development of online SLM were scheduled appropriately based on the short special-term program. E.g., “Man and Universe”, “Theories about Motion”, and “Laws of Motion” topics in the physics area of physical science were all part of SLM 1, and “Dual Nature of Light”, “Special Theory of Relativity”, and “General Theory of Relativity” topics were all part of the SLM 2. With this, the ambition to attain quality education during the short conduct of the special term program was not compromised.

Conduct of Validation Procedures – Phase 1: The researcher had chosen the University of Santo Tomas and Polytechnic University of the Philippines professionals because of their success in the teaching field, educational background, and experiences in evaluating instruments and handling research projects both national and international. After this, all comments and suggestions were incorporated for the betterment of the manuscript.

Test and Retest Results of the Online SLM – The developed online SLM passed through a two-way evaluation wherein the prototype SLM got tested initially by a panel of experts using the validated questionnaire. Their feedback, comments, and recommendations were collated and finally incorporated into the redeveloped and

improved online SLM. Then, the finalized SLM got retested again by the same panel of experts using also the same validated questionnaire.

Reliability of the Online SLM –After the conduct of the test using the validated questionnaire, the reliability of the test evaluation followed. All the comments and suggestions were collated and incorporated into the redeveloped online SLM. Then, after the conduct of the retest using the same validated questionnaire, the reliability of the retest evaluation followed.

Significant Difference Between Test-Retest Results and the Online SLM’s Set Criteria – This procedure provided information if the t-test for paired samples (correlated means of the test and retest) on a particular criterion of the questionnaire was exactly zero difference or different from zero.

Ethical and Legal Collection of Pertinent Information – After an email confirmation was sent to the questionnaire validators and panel of experts, consent forms at the beginning of the Google form will also have to be declared so any objection to the collection of information shall be addressed in no time. If the evaluators agreed to give their full consent and wished to participate in the validation of the questionnaire procedures and evaluation of the prototype developed online SLM respectively, then the information gathered would be securely treated with the strictest confidentiality and would be solely used for the betterment of this academic pursuit.

Data Analysis

Both test and retest results were treated with descriptive statistics. Means and standard deviations were sought to measure how close the standard deviation was to the mean in each criterion. All the data gathered were facilitated through the SPSS software of the licensed statistician.

To find out the consistency or reliability of the developed online SLM in physical science, test-retest reliability was employed to measure the degree to which the pursuit had produced stable or consistent results by conducting the same

questionnaire twice having the same sample. (Dudovskiy, 2011).

Further, the Likert scale on the questionnaire was used to determine if both test and retest evaluation results is reliable or not reliable using Cronbach’s alpha.

To determine the significant difference in the evaluation results of the test and retest on the developed online SLM, the paired samples t-test was used to compare the means of the test and retest evaluations using the same validated questionnaire and the same evaluators.

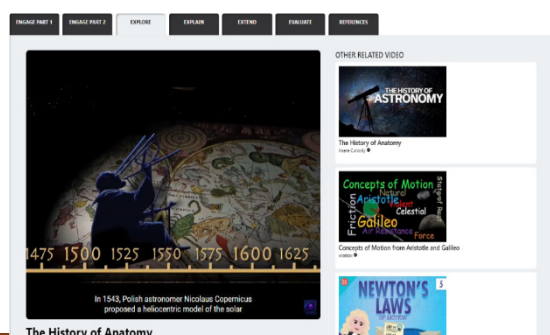
III. RESULTS AND DISCUSSION

The researcher gathered information and browsed various web designs to finally visualize a kind of web layout that will be put into the developed online SLM that suits well the Gen Z type of learners and the UST-SHS LMS. Below were some of the special features of the developed online SLM in physical science.



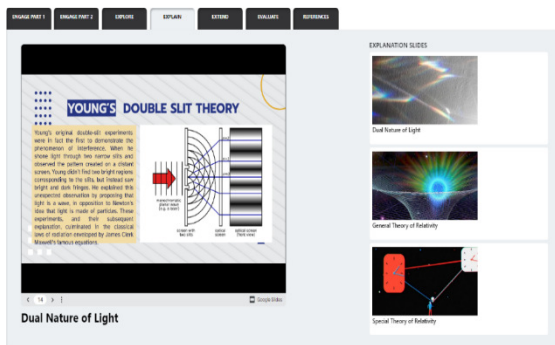
Easy Accessibility

The online SLM will let the learners have their virtual simulation on the webpage itself without redirecting them to the main account. Thus, this saved their time accessing the main website of the used simulation, especially since internet connections here in the Philippines were not reliable.



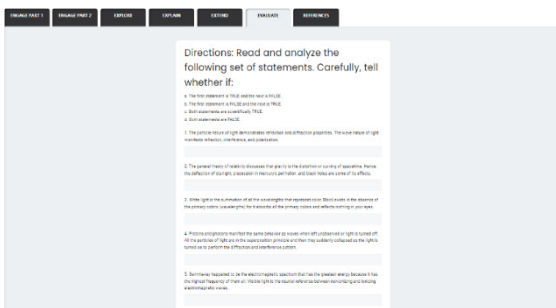
Embedded YouTube References

Students need not worry about the credible references to look for because the online SLM provided them with many of the references collected just to sustain the information needed for them. All the features of YouTube such as video size, volume, annotations, quality, subtitles, and playback speed were also included so students can watch the videos at any time of their choosing with all the options in their hands.



Friendly User's Options

PowerPoint (PPT) presentations can be easily studied anytime anywhere by clicking the tab for the PPT tab of their choice, and they will get directed to the lesson they are looking for with the special features at the bottom to explore.



Direct Assessments

All the summative assessments for SLM 1 and 2 Google forms can be directly taken in the module anytime anywhere. Also, they can backtrack the questions whenever an interruption in Wi-Fi arises, everything is saved appropriately.

Measures of Central Tendency and Variability of All the Criteria

In terms of the measures of central tendency and variability of all the criteria used in the evaluation of the developed online SLM, it can be inferred that it was overall reliable and showed a very high manifestation both for test and retest. Specific objectives obtained test and retest means of 3.54 and 3.93 and standard deviations of 0.448 and 0.185 respectively. Content obtained test and retest means of 3.53 and 3.98 and standard deviations of 0.539 and 0.060. The language obtained test and retest means of 3.76 and 3.96 and standard deviations of 0.356 and 0.081. Appropriateness and novelty obtained test and retest means of 3.47 and 3.96 and standard deviations of 0.560 and 0.081. Evaluation activities obtained test and retest means of 3.62 and 3.98 and standard deviations of 0.460 and 0.603.

Test Reliability Analysis of the Developed Online SLM

Scale	Cronbach's Alpha	Interpretation	Decision
All Variables	0.967	Reliable	Retain the developed online SLM in physical science

It showed the reliability analysis of all the questions used in the instrument to evaluate the developed online SLM in physical science for the test part. The calculated data explains that the online SLM developed in physical science is highly reliable since Cronbach's alpha of 0.967 exceeds the acceptable value of 0.7. Therefore, the instrument used is retained.

Retest Reliability Analysis of the Developed Online SLM

Scale	Cronbach's Alpha	Interpretation	Decision
All Variables	0.874	Reliable	Retain the developed online SLM in physical science

The calculated data explained that the online SLM developed in physical science is highly reliable since Cronbach's alpha of .874 exceeded the acceptable value of 0.7. Therefore,

the instrument used was retained even after its retest. The reliability index for both test-retest reliability showed consistent and stable results as both of them obtained Cronbach’s alpha values of 0.967 and 0.874 respectively which were higher than the threshold value of 0.7 for the researcher-developed instrument.

Paired Samples T-Test on Specific Objectives

Criterion	Mean	Standard Deviation	t-value	Sig. Value	Interpretation	Decision to H ₀
Specific Objectives						
Test	3.55	0.448	-2.65	0.0240	Significant	Reject
Retest	3.93	0.185				

$\alpha = 0.05$ Level of Significance

It can be gleaned from the table that there is a significant difference between the test and retest evaluation in terms of specific objectives criterion reflective of the t-value of -2.65 with a p-value < 0.05. Hence, the null hypothesis was rejected.

Paired Samples T-Test on Content

Criterion	Mean	Standard Deviation	t-value	Sig. Value	Interpretation	Decision to H ₀
Content						
Test	3.53	.539	-2.77	0.0200	Significant	Reject
Retest	3.98	.0603				

$\alpha = 0.05$ Level of Significance

The data gathered explained that there was a significant difference between the test and retest evaluation in terms of content criterion reflective of the t-value of -2.77 with a p-value of 0.0200 which was less than 0.05. Hence, the null hypothesis was rejected.

Paired Samples T-Test on Language Used

Criterion	Mean	Standard Deviation	t-value	Sig. Value	Interpretation	Decision to H ₀
Language Used						
Test	3.76	0.356	-1.75	0.111	Not Significant	Accept
Retest	3.96	0.0809				

$\alpha = 0.05$ Level of Significance

The data gathered revealed that there was no significant difference between the test and retest evaluation in terms of the language used criterion reflective of the t-value of -1.75 with a sig. value of 0.111 which was greater than the p-value of 0.05. Hence, the null hypothesis was accepted as the evaluators found the language used for the test and retest straightforward, plain, and simple.

Paired Samples T-Test on Appropriateness and Novelty

Criterion	Mean	Standard Deviation	t-value	Sig. Value	Interpretation	Decision to H ₀
Appropriateness and Novelty						
Test	3.47	0.561	-2.90	.0160	Significant	Reject
Retest	3.96	0.0809				

$\alpha = 0.05$ Level of Significance

The data gathered revealed that there was a significant difference between the test and retest evaluation in terms of the appropriateness and novelty criterion reflective of the t-value of -2.90 with a p-value < 0.05. Hence, the null hypothesis was rejected.

Paired Samples T-Test on Evaluation Activities

Criterion	Mean	Standard Deviation	t-value	Sig. Value	Interpretation	Decision to H ₀
Evaluation Activities						
Test	3.62	0.460	-2.51	.0310	Significant	Reject
Retest	3.98	0.0600				

$\alpha = 0.05$ Level of Significance

The data gathered inferred that there was a significant difference between the test and retest evaluation in terms of the evaluation activities criterion reflective of the t-value of -2.51 with a p-value < 0.05. Hence, the null hypothesis was rejected.

Paired Samples T-Test on the Overall Means

Overall Means	Mean	Standard Deviation	t-value	Sig. Value	Interpretation	Decision to H ₀
Test	3.59	0.430	-2.86	.0170	Significant	Reject
Retest	3.96	0.0848				

$\alpha = 0.05$ Level of Significance

The data gathered inferred that there was a significant difference between the test and retest evaluation in terms of the overall means of all the criteria reflective of the t-value of -2.86 with a p-value < 0.05. Hence, the null hypothesis was rejected.

IV. CONCLUSION

On the bases of the findings of the study, there was a confirmation of the research hypothesis that a significant difference existed between the test and retest results of the online SLM in terms of specific objectives, content, appropriateness and novelty, and evaluation activities. Therefore, the null hypothesis was rejected. However, there was a confirmation of the research hypothesis that no significant difference existed between the test and retest results of the online SLM in terms of the language used. Therefore, the null hypothesis was accepted.

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