MODELLING SPARK INTEGRATION IN SCIENCE CLASSROOM

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ABSTRACT

The study critically explored how a PASCO-designed technology (SPARK ScienceLearning System) is meaningfully integrated into the teaching of selected topics in Earth and Environmental Science. It highlights on modelling the effectiveness of using the SPARK Learning System as a primary tool in learning science that leads to learning and achievement of the students. Data and observation gathered and correlation of the ability of the technology to develop high intrinsic motivation to student achievement were used to design framework on how to meaningfully integrate SPARK ScienceLearning System in teaching Earth and Environmental Science. Research instruments used in this study were adopted from standardized questionnaires available from literature. Achievement test and evaluation form were developed and validated for the purpose of deducing data needed for the study. Interviews were done to delve into the deeper thoughts and emotions of the respondents. Data from the interviews served to validate all numerical data culled from this study. Cross-case analysis of the data was done to reveal some recurring themes, problems and benefits derived by the students in using the SPARK ScienceLearning System to further establish its effectiveness in the curriculum as a forerunner to the shift towards the 21st Century Learning.

Keywords: Environmental Science; Technology Integration, Pedagogy, Model for technology integration, TPACK

I. INTRODUCTION

Dr. Douglas Kellner (2002) claimed that in many countries today's students are referred to as "digital natives", and today's educators as "digital immigrants." This means that the new millennium was ushered in by a dramatic technological revolution. There is a dire need for teachers to work closely with students whose entire lives have been immersed in the 21st century media culture. This enculturation of students as digital natives is described as P21 or better known as "Partnership for 21st Century Skills".

Background of the Study

Researches claimed that integrating technology in the curriculum and instruction will bring about significant student achievement leading to deep understanding of concepts. Studies have also shown that technology has to be integrated meaningfully into the curriculum and instruction, for probable positive impact on student learning and achievement. "Meaningful integration" of technology refers to the process of matching the most effective tool with the most effective pedagogy to achieve the learning goals of a particular lesson. Each tool brings different opportunities to the learning environment and involves a different set of skills on the part of teachers and students. Each can play a unique role in the learning process when used at the appropriate time, under the most appropriate learning conditions. It is simply the degree to which a particular technology's capabilities are matched with the expected learning outcomes and supported by appropriate pedagogy that will determine the impact that technology has on learning and achievement (Clark 2010).

Motivation

As mentioned by Slavin (2003), one of the many aspects that can help foster better achievement by students in the classroom is motivation. He further defined motivation as "what gets you going, keeps you going, and determines where you want to go". Many researches (Brookhart et.al. 2006, Palmer 2005, and Mazer, Murphy& Simonds2007) provide a notion that motivation is the key component in reaching a high level of student achievement.

If students set meaningful goals that are attainable, they will progressively achieve higher results. There is a need to provide students with a distinct set of goals which can help them be motivated. Martin (2006) further suggested that if students have predetermined goals they will strive for personal bests with a higher level of motivation.Mazer, Murphy & Simonds (2007) claimed that teachers can play a large role in determining the motivation level of the students in the class. Studies on the effects of teacher self-disclosure on student motivation using Facebook web-based software as medium for disclosure conclude that students were more motivated when their teacher shared some personal information about themselves. However, some disadvantages of this self-disclosure surfaced with too much self-disclosure which led to non-elicitation of same motivation. (Mazer, Murphy & Simonds, 2007)

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Technology Integration and Learning

According to history, educational technology has been defined in numerous ways. It is usually focused on the teacher and the pedagogies that might be employed on the learner. Four paradigm shifts highlights the 20th century each with different philosophical and theoretical orientations, affected theory, practice and definitions of educational technology. These are characterized as "the physical science or media view; the communications and systems concept; the behavioral science-based view; andthe cognitive science perspective" (Saetller 2004). The definition shifts to leaning towards learning technologies and on how instructional technologies can best serve learning in the 21st century framework. The Association for Educational Communications and Technology (AECT) defines educational technology as "the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources" (Richey, Silber, & Ely 2008).

Current researches have been conducted on the goodness and effectiveness of technology as integrated into the curriculum or instruction. Floyd et. al. (2008) claimed that incorporation of technological advances should be a key component in designing the most effective and innovative emergent literacy intervention. Mishra & Kohler (2006) mentioned that successful technology integration requires that educators blend strong content knowledge with appropriate pedagogical strategy. From which, they were able to come up with Technology-Pedagogy-and–Content Knowledge or TPACK framework. This is the highlight of P21 or known as Partnership for the 21st Century Skills which centered on the "meaningful" integration of technology. Integrating technology in meaningful ways involves matching instructional tools with curricular goals, desired student outcomes and instructional practice. Choosing the "right" tool for a learning task requires not only familiarity with the kinds of tools available, but also depends upon an understanding of *how* those tools can support the development of desired knowledge and skills. As with any tool selected for any purpose, the choice of what technology to use and how to use it must be guided by a set of beliefs---a vision-- for how learning is best supported (Clark 2010).

This match of the technological tool with the pedagogy and curriculum is the main focus of the study. Further, the research would want to establish that this match is feasibly achieved by the attributes of the teachers as the "digital immigrants" working collaboratively with the students as the "digital natives" to help foster the intended partnership and be with the P21 flow. The information provided by this research is of value to science teachers working on similar objectives. This also allows science teachers to explore and improve on their motivation techniques which may later lead to a deep conceptual understanding of the subject matter. Further, the results would help establish effectiveness of technology inspired science classroom in trying to be at par with the 21st century learning.

II. OBJECTIVES OF THE STUDY

The purpose of this paper is to examine the use of SPARK technology in Earth and Environmental Science classes. The specific research objectives in this paper are to establish: the effect of using the use of SPARK devices on student motivation; and the effect of using SPARK learning system on student achievement. This paper also presents a way to integrate technology in science classes and adopt them to the 21st century learning.

III. MATERIALS AND METHODS

Mixed methods were used in order to gather data and pertinent observations regarding the use of technology in the classroom. Quantitative part was done to statistically establish gains and differences. Qualitative approach highlighted the validation of the statistically established gains and differences. It was also used to delve deeper into the thoughts of students as inputs to modelling SPARK integration in science classes.

Participants

An intact class of tertiary students who were specializing in physics and were enrolled in both Computer Literacy 1 and Earth and Environmental Science classes were the participants of the study. These are the pre-service physics students of the Philippine Normal University-Manila. They are the set of students also known as the DOST-SEI-PNU scholars who also enjoy the consortium benefits with the De La Salle University, Manila. As DOST-SEI-PNU scholars, these students were nationally selected to enjoy the benefits of the grant and be future Physics teachers. They were recruits from different science oriented and non-science oriented high schools all over the Philippines.

Materials and Instruments

a. SPARK Learning System

The SPARK Science Learning System used in this study is an all-in-one mobile device that integrates the power of probeware with inquiry-based content and assessment. The device includes a large, full-color display, finger-touch navigation and data collection and analysis capabilities. It is designed to become a discovery-based science learning environment, providing both the teacher and the students the embedded support for exploring science concepts. It has more than 60 free pre-installed SPARK-Labs which are standard-based guided inquiry labs in a unique electronic notebook format that integrates background content, data collection, analysis, and assessment.

b. Literacy and Technology Checklist

This is a checklist that would help establish the students' knowledge and know how in technology, literacy and web expertise which is a requisite to the use of SPARK Science

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Learning System. It included three major parts: background information, technology component, and literacy and web expertise. Part 2 highlights the technology component using Likert scale system while the other components are in open-approach.

c. Intrinsic Motivation Inventory

The Intrinsic Motivation Inventory (IMI) is a multidimensional measurement instrument intended to assess participants' subjective experience related to a target activity in laboratory experiments. It has been used in several experiments related to intrinsic motivation and self-regulation (Gottfried, 1986). There are several version of this inventory. Only 2 of these versions were utilized in the present study: the full 45 items that complete the 7 subscales, and the 25-item version that was used in the internalization study, including the three subscales of value/usefulness, interest/enjoyment, and perceived choice.

d. Achievement Test

This is a 19-item test which has undergone content validation by 3 science experts and science educators and item analysis procedures that has trimmed the question set from 25-items to 19-items. The test covered topics in radiation and insolation which are the major topics on which the SPARK Science Learning System were integrated.

e. Evaluation Form

This included 13survey questions in Likert scale intended to determine insights of the students on the use of SPARK Science Learning System as a technology in the teaching and learning of science concepts. This was administered after instruction integrating the SPARK Science Learning System. Students were asked to tick on the appropriate cell. Part of the form included questions related to the advantages of using SPARK Science Learning System in open-ended format.

Procedure

a. Phase 1

This is the preparation phase of the study. All materials and instruments needed for the study are set for administration and implementation. Correspondence with De La Salle University's physics laboratory technicians and computer literacy instructor of the participants were done prior to implementation of the SPARK Science Learning System integration. Literacy and Technology Checklist, Intrinsic Motivation Inventory, and Pre-Test (Achievement Test) were administered as pre-intervention procedure. With these in place, try out sessions were done with the participants to orient them with the use and technicalities of the SPARK Science Learning System.

b. Phase 2

The focus of the succeeding sessions was on integrating the SPARK Learning System to two major topics in Science 3 (Earth and Environmental Science). The two major topics: radiation and insolation, in the course syllabus of Science 3 (Earth and Environmental Science) were selected for the purpose of the study. Session plans were prepared to map out the integration and instruction of the selected topics.

c. Phase 3

To determine the effect of the SPARK Science Learning System, a post-test was administered to the participants. Post-test results were compared statistically to the results obtained in the pretest to determine gains if any. Post-experimental Intrinsic Motivation Inventory and evaluation of the integration of SPARK were administered to determine whether the students were intrinsically motivated by the integration of the SPARK Science Learning System. Interviews were conducted to selected students to facilitate the validation of students' answers in the different questionnaires. Analysis of the results of the tests and questionnaires were done to establish significant gains in student achievement and statistical correlation of intrinsic motivation and meaningful integration of technology in science classes.

IV. RESULTS AND DISCUSSION

The 2 primary goals of the study were to establish the effect of integrating the SPARK Learning System on student motivation and to determine significant gain in student achievement using the SPARK Learning System.

a. Pre-Instruction

Profiling of students was conducted prior to instruction using the integration of the SPARK Science Learning System, to determine their background information and their technological literacy. Since every participant is a scholar of DOST-SEI, these students are highly motivated to study Physics. Thus, SPARK Science Learning System was integrated to Earth Science lessons instead of lessons in Physics.

Shown in Table 1 are the background information and the summary of the technology literacy of the participants. All students were graduates of public high schools directly administered and monitored by the Department of Education. Everyone finished their secondary level either from science oriented schools, science high school or DOST node school. These participants can be said to be at par with one another in terms of learning experiences. Further, it can be inferred that majority of these students do have access to computers with internet capabilities. This may be through the Learning Resource Center (LRC) provided by DOST-SEI & PNU and the consortium benefits with the De La Salle University, Manila.

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Table 1
Technology Literacy Checklist

Respondent	Gender	High School	Access on Technology	Experience with Technology	Computer Literacy and Web Expertise
R1	Male	Marikina Science High School	0.7	0.9	0.8
R2	Male	Ramon Magsaysay Cubao High School	0.7	0.9	0.6
R3	Female	Tala High School	0.7	0.8	0.5
R4	Female	LPNHS (main)	1.0	0.9	0.8
R5	Female	DARSSTHS	1.0	0.8	0.6
R6	Female	Patoc National High School	1.0	0.8	0.4
R7	Female	Ramon Magsaysay Cubao High School	1.0	0.8	0.5
R8	Female	Sorsogon national high school	1.0	0.8	0.7
R9	Male	Jonu Rural School	1.0	0.7	0.4
R10	Female	Muntinlupa Science High School	1.0	0.7	0.7
R11	Female	Rizal National High School	1.0	0.8	0.8
R12	Female	Lagro High School	1.0	1.0	0.8
R13	Female	NOHS	0.7	0.6	0.5
R14	Female	Jose P. Laurel High School	1.0	1.0	1.0
R15	Female	Rosario National High School	0.7	0.8	0.7
R16	Female	San Jose National High School	1.0	0.8	0.5
R17	Male	Pasay City South High School	1.0	0.9	0.8
R18	Male	Ramon Magsaysay Cubao High School	1.0	0.8	0.7
R19	Female	Cavite National High School	1.0	0.9	0.8
R20	Female	Paranaque national High School-Lahuerta	1.0	0.8	0.7
R21	Female	Cavite National High School	1.0	0.9	0.7
R22	Female	MORMS	1.0	0.8	0.4
R23	Female	Mount Carmel School Of Infanta	1.0	0.8	0.7
R24	Male	Binan National High school	1.0	0.9	0.7
R25	Male	Baclaran high School	1.0	0.9	0.7
R26	Male	DARSSTHS	1.0	0.8	0.7
R27	Male	Paranaque National High School-Lahuerta	1.0	0.8	0.6
AVERAGE			**0.9**	**0.8**	**0.7**

Majority of the participants use computers and other computer related technology for personal interest and lesson-related activities which make their usage a part of their daily routine. Thus, it can be inferred that they are well-versed in manipulation of devices and technology which has the same features as that of a computer. They can be considered ready users of the SPARK Science Learning System.

b. Instruction

The try-out of the integration of the SPARK Science Learning System in selected topics was conducted in several sessions. The first session was the orientation on the SPARK Science Learning System which was conducted at the Philippine Normal University. In this session the researcher presented the visual reference, the user's guide, and the quick start guide to the participants. Discussions on how to use the

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instruments and some comparison with the classical laboratory procedure were also presented and discussed with the participants. The first impressions of the participants included the following: the instrument maybe very expensive and they expressed some anxiety on the use for reasons that they may damage the said instrument. Further discussions on the said instrument was done by comparing SPARK with some common and familiar technology these participants are adapted to these days like the touch screen mobile phones and PSPs helped them concretely visualize the introduced technology (SPARK Learning System).

The succeeding sessions were focused on hands-on orientation on the instrument and integration of the SPARK Science Learning System on selected topics in Science 3 (Earth and Environmental Science) - Radiation and Insolation. The integration procedure followed a pedagogically accepted process as presented in the session plans prepared by the researcher and content validated by experts including the researcher's consultant. Within the short span of time students were able to come up with good results using the SPARK Learning System.

c. Post-Instruction

Paired sample t-test was done to determine if there was a significant gain in the pre-test and post-test of the participants.

Table 2
Paired Sample Statistics
N = 25

Pair	Pre Test Mean	Post Test Mean	p-value
Pre-Test and Post-Test	9.00	13.60	0.00*

(*)Significant at 0.05

Based from table 2, the participants performed better in the post test as compared to the pre-test with the given intervention. The difference in the pre-test mean and the post-test mean (4.640) was statistically significant with a p-value less than the accepted at 0.05 level of significance (p-value = 0.00 < 0.05). As targeted, the integration of SPARK Science Learning System has brought about significant gains in the student achievement. This implies that the integration of SPARK Learning System in selected topics in Earth and Environmental Science is highly effective.

Table 3 showed that the post-test has a mean value of 13.64 out of the 19-item test. Evaluation has a high mean values (4.75 out of 5) while intrinsic motivation has moderate mean value of 5.68 out of 7. The high mean value of the evaluation of the SPARK Science Learning System is complemented by the student answers in the open-ended portion of the evaluation.

Table 3

Correlation of SPARK Evaluation, Post-Test and Intrinsic Motivation

Categories	Post-Test	Evaluation	Intrinsic Motivation
Mean	13.64	4.75	5.68
Pearson			
Post-Test	1.00	-0.063	0.618*
Evaluation	-0.063	1.00	-0.353
Intrinsic Motivation	0.618*	-0.353	1.00
Model Summary**		**0.464****	

(*) Significant at 0.05
*** Predictors: Post-Test, Evaluation & Intrinsic Motivation*

They positively identified several advantages as follows:

> *"Learners will now find it easy and fun to do experiment. The results will be no doubt accurate."*
> *"The SPARK is very useful during the experiments; students can easily record data accurately while doing the graphs and tables at the same time."*
> *"Besides from being handy, it is also good in understanding a concept because the background gave the information about the concept and after this is a follow up question that will help the student think."*
> *"It gives background concepts on the activity to be performed and asks questions to tests out knowledge on the topic."*
> *"Results are readily be seen…continuous to record data and can be saved."*
> *"The device can be easily manipulated. It provides learners with necessary guide questions that directly lead to further understanding of the lesson and its concepts."*
> *'The concepts are already stated in the activities."*
> *"It's accurate, innovative, safe."*

Similar answers were provided by the selected participants during the post-instruction interview. They were able to point out how the SPARK learning system was helpful and engaging to students. They attested that SPARK learning system is novel to them and is very visual in perspective which matches their need and learning style. However, they have also identified several areas of improvement in integrating SPARK learning system in science lessons to make learning much more meaningful and appreciated by students.

> *"Na-amaze ako mam sanagagawang instrument or device." (I was amazed with what the instrument can do.)*

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"Yes mam, the SPARK Learning System helped a lot. I was able to answer the follow up questions with ease and also the evaluation questions."

Mam sometimes it's hard to learn using books alone because they are not that much available or engaging, unlike the SPARK, it has a way of making interactions work out.

"Yesmam, satuladkopona madalimakaintindipag may illustrations masmagandaparasaaminangmgaganitong device para mas maintindihan and concepts." (Yes Mam, for student like me who hardly understands concepts in science but can possibly do so with good visuals.)

"I would recommend the use of SPARK Learning system but in partnership with written outputs, written graphs and computations."

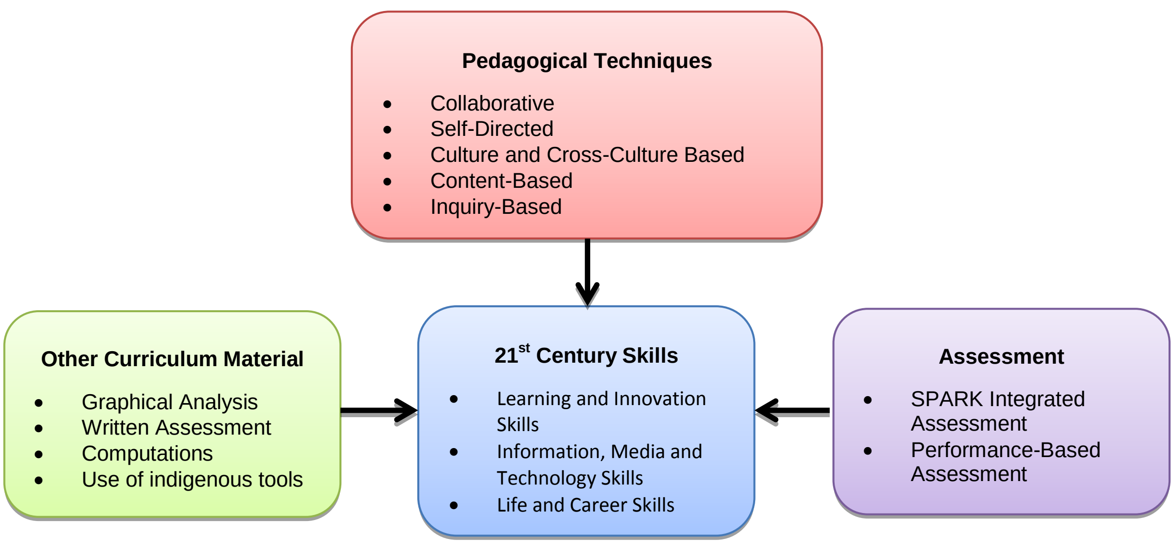
Positive significant correlation is observed between post-test and intrinsic motivation. The other pairs – post-test & evaluation and intrinsic motivation & evaluation posit non-statistically significant correlation. As pointed out in the post-instruction interview, these pre-service students believe that the full potential of SPARK learning system may be achieved in combination with other written curriculum materials. The positive correlation of post-test and intrinsic motivation could mean that they were already highly motivated in the subject area as they are science-oriented students but this intrinsic motivation is hardly identified with the integration of the SPARK learning system.

Further, low positive correlation of three variables presented in the "model summary" was observed with an R-value of 0.464. This is lower than the usually accepted value of 0.5. This implies that there may be other constructs of learning which are better predictors of student achievement other than the evaluation of the technology (SPARK) and the post-experimental intrinsic motivation. The result is complemented by students' answers when asked about some disadvantages of using the SPARK Learning System as follows:

"Graphing skills of the students and manipulating data may be affected negatively."
"Less interaction or cooperation among students since it can be done individually."
"The students will be lazy and always depends on the SPARK."
"The students might just rely on the tool in graphing and not do it manually."
"There will be little interaction between the teachers and the learners. Learners will only depend on the approaches."

Model Building and Framework for Integration of SPARK Learning System

In preparation for the shift towards P21 or 21st Century Learning, integration of SPARK Learning System could touch grounds on learning and innovation skills which focus on creativity, critical thinking, communication and collaboration. Embedded in the learning system are activities that could promote the needed attributes of students to attain learning and innovation skills. With SPARK, students could be able to exhibit a range of functional and critical thinking skills related to information, media and technology. Manipulation of the SPARK system gives students more opportunities to develop skills related to information, media and technology. Life and career skills are also needed for students to navigate the complex life and work environments in the globally competitive information age. This can be achieved through combination of the SPARK learning system with other curriculum materials that may develop the latter identified skills. These are the needed skills of a new generation student to be able to adapt and be successful citizen.



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The model or framework presented in figure 1 captures all the deduced ideas from the study. It was identified that integration of the SPARK Learning System was effective to a certain extent. Low correlation observed was attributed to the sole integration of the SPARK learning system in the pedagogy. It was noted that probable combination of other curriculum materials and other forms of assessment could lead to much more meaningful integration of the SPARK Learning System. As claimed by Mishra & Kohler (2006), successful technology integration requires that educators blend strong content knowledge with appropriate pedagogical strategy. This is known as Technology-Pedagogy-and–Content Knowledge or TPACK on which the designed model is aligned.

V. CONCLUSIONS AND RECOMMENDATIONS

The foci of this study were to establish the effectiveness of the integration of the SPARK Science Learning System on selected topics in Earth and Environmental Science and to determine whether or not integration of SPARK Science Learning system positively affect student motivation eventually leading to student achievement. The intervention administered or conducted was effective that lead to a significant gain in the pre-test and post-test mean difference. This implied a meaningful integration of the SPARK Learning System on Earth and Environmental Science. The integration of the SPARK Science Learning System also had positive effects on student post-experimental intrinsic motivation and was evaluated positively by the respondents. These were separately manifested in the means or averages of the data sets. However, it was noted, that 2 of the 3 variables: post-test, evaluation, and post-experimental intrinsic motivation had low positive correlation. This implied that although the integration was effective, constructs other than student motivation and evaluation of the integrations contributed to the mean gain in the pre-test and post-test difference. Post-instruction interview with the students provided other details of the low correlation and the probable much more meaningful integration of the SPARK learning system. The designed model or framework captured all study results for meaningful integration of technology (SPARK) leading to development of 21st century skills as preparation to P21 learning.

Replication of the study is needed to establish effectiveness of meaningful integration of technology in learning Science. A study to test the designed model may help launch meaningful integration of technology that leads to development of the 21st century skills. More respondents can also help strengthen the research finding.

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