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ORIGINAL ARTICLE

Integrating Ivatan Indigenous Games to Learning Module in Physics: Its Effect to Student Understanding, Motivation, Attitude, and Scientific Sublime

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ABSTRACT

The Philippines is lagging behind in physics education based on recent results of national and international assessments. With a continuing endeavor to address this problem, a game-based learning module was innovated using the Analysis – Design – Development – Implement – Evaluate model, integrating Ivatan indigenous games in a learning module in physics, to probe the effect of the developed module on Ivatan students' understanding, motivation, attitudes, and scientific sublime. Furthermore, the study aimed to reintroduce the Ivatan indigenous games to the younger Ivatan learners of Batanes, Philippines, through physics, in an attempt to help preserve its culture and traditions by integrating it to the teaching-learning process. The module underwent validation among four experts which yielded a highly acceptable and a good agreement rating. The material was tested with twenty SHS students under the STEM strand in a quasi-experimental research setup. A thirty-item test, the Physics Motivation Questionnaire II, the Colorado learning attitudes toward science survey, and open-ended journal questions were the instruments used to test the module's effectiveness. Results revealed a significant difference ($M_{diff} = -2.65$) in student understanding with a 0.31 small effect size; students' motivation revealed a significant difference ($M_{diff} = -0.91$) with a large effect size of 0.86; and student attitudes revealed a significant difference ($M_{diff} = -0.44$) with a medium effect size of 0.78. The correlation between understanding, motivation, and attitudes ($r_{und-mot} = 0.65$; $r_{und-att} = 0.83$; $r_{mot-att} = 0.72$) was all positive uphill relationships. Finally, responses from the journal revealed that the most common feedback among learners was the extreme feeling of happiness while generating only 5% of sublime feelings such as extreme awe/amazement/overwhelmed. These results revealed that the developed material effectively improved students' understanding, motivation, and altering attitudes to a favorable state while realizing that it is unsuccessful in fostering scientific sublime.

KEY WORDS: Attitude, Batanes, game-based learning, Ivatan culture, motivation, Philippines, scientific sublime, understanding

INTRODUCTION

For the past century, one of the most common stated objectives of science education from all over the world is to help students develop a proper understanding of its nature (Mohan, 2018), theories, and applying its concept to practical situations (Gasparatou, 2017). For a learner to have a better grasp of science as a whole, understanding physics must come first (Hewitt, 2014). Taale (2011) states that physics, revered for being the most basic of all sciences and known as the foundation of our civilization, is vital in every country's technological advancements and economic development as observed and applied in our everyday life. However, despite its beauty, immense knowledge, and countless applications, the reputation of physics education here in the Philippines lags compared to other countries. International and national evaluations show that the Philippines is not performing well. For example, the Philippines was in the bottom two of the PISA 2018 rankings for performance in science among 79 participants from partner countries such as China, Singapore, Japan, United States, and Australia (Department of Education, 2019). Similarly, Trends in the International Mathematics and Science Study from years 1995, 1999, and 2003 the Philippines were ranked below average when compared to other participating countries (Orleans, 2007); and the country's measurement for 21st-century skills of learners based on the 2018 National Achievement Test (NAT) results revealed a mean percentage score of 31.81 in science, way below the standard score of 75.00 (Department of Education, 2019).

Based on the aforementioned international and national evaluations, poor student achievement also reflects the state of science education here in Batanes. NAT results of the whole province from the school year 2008–2009 to 2017–2018 for the subject Science revealed a below qualifying score of 57.81%, 46.16%, and 33.38%, respectively, compared to the 75.00% passing score set by the department of education. These observations have prompted educational researchers locally and even at the national level to determine factors that affect such outcomes inside the classroom to increase students' physics achievement. Badeo (2019) pointed out that students' understanding, motivation, and attitudes toward learning physics were the key factors that should be considered addressing the challenges to improve physics education in the country.

Studies by Atasoy and Arkdeniz (2005) revealed a struggle among students, ranging from elementary level to collegiate level in understanding general physics concepts. These topics were force, motion, and acceleration. Thus, students fail to comprehend most of the materials taught in science subjects since these concepts were seen to be abstract (Atasoy, 2008; Bayraktar, 2008; Carmen et al., 2015). Moreover, learners often report seeing physics as a difficult subject (Carmen et al., 2015; Morales, 2016; Saleh, 2012; Tural 2013), dealing with different representations, experiments, calculations, and learning the concept all at the same time (Ornek et al., 2008). With this kind of undesirable notion, students develop an unfavorable attitude toward learning physics. They perceive the course as being too dull and irrelevant, consequently information is quickly forgotten because students fail to connect concepts of physics to real-life and day-to-day activities (Carmen et al., 2015). Furthermore, attitudes are one's set of beliefs regarding the nature of physics and its processes of knowledge attainment (Adams et al., 2006). It also signifies interest or feeling toward studying physics, either liking or disliking it (Mensah et al., 2013), which dramatically influences their study habits, which associates with their conceptual development (Chu et al., 2008). Osborne et al. (2003) suggest that attitudes toward learning a particular subject give out the best prediction of outcomes in terms of learner success and achievement. To achieve excellent learning outcomes in physics, transforming unfavorable attitudes to positive attitudes should be done since the latter are highly correlated. Furthermore, since attitudes are considered a factor in conceptual attainment, student motivation affects their attitude toward learning (Guido, 2013) because motivation is directly related to attitude (Badeo et al., 2015). Carmen et al. (2015) reveal that studies show significant positive associations among student attitudes, motivation, and conceptual understanding (Guido, 2013; Hofer, 2001; Kiong and Sulaiman, 2010). Locally, despite the small number of studies conducted in Batanes, using new innovative set of learning materials shows that it helps learners in understanding and promotes better motivation in learning the subject; however, there were no studies to date regarding gamified learning activities that integrates physics concepts like the research initiative conducted.

As such, once a learner starts understanding the physics ideas and is able to apply these concepts in their day-to-day experiences, science sublime arises from it (Cavanaugh, 2014). Scientific sublime is a new construct that describes the mixture of strong emotions such as feelings of awe, wonder, appreciation, astonishment, and fear, all of which are inspired by phenomena, events, or experiences, particularly in science (Girod, 2001). Furthermore, Cavanaugh (2014) stated that sublime attracts people to study science and sustains their interest in that particular subject area. To address this dearth of information, exposing students to different learning styles and pedagogies tend to increase the levels of motivation (Adesoji, 2008; Guido, 2013), shift to positive attitudes toward learning physics (Badeo et al., 2015; Torio and Cabrillas-Torio, 2016), understanding of physics concepts (Arslan and Devecioğlu, 2010), and to foster scientific sublime from the combination of understanding and extreme emotion (Cavanaugh, 2014). It is in line with the recent Filipino education reform known as the K to 12 Basic Education Curriculum, that its essence is to immerse learners into innovative 21st-century learning styles to make learning more engaging and exciting (Department of Education, 2019). Besides, adequate and varied instructional materials for the classroom help aid the diverse learning styles of the students (Orleans, 2007). Accordingly, to address the diversity of learners and learning styles, Morales (2014) stated that linking culture with learning physics is observed to improve learner's concept attainment since they see physics in enhancing the knowledge of their roots, which consequentially increases their motivation to learn. According to Savard et al. (2008), culture refers to the set of customs, artistic, religious, usages, beliefs, traditions, and intellectual expressions that define and distinguish a group, and a society.

Batanes, the Philippines (the study locale) is rich in culture in terms of its scenery, its natives, history, customs, beliefs, and traditions (Delos Santos, 2016, Esteban and Valientes, 2019; Hidalgo, 1996). The Ivatans (natives of Batanes) and their culture are a combination of the ancient Ivatans and subsequent foreign cultural influences (Loo et al., 2011; Quismundo, 2015; Veld, 2014). Despite not preserving their indigeneity entirely due to the synthesis above, their culture developed and strengthened as it still permeates the Ivatans up to this day. Moreover, Carmen et al. (2015) specified that culture could either be tangible such as tools and technology or non-tangible like practices, beliefs, and traditions, which includes traditional games of that ethnicity. The Philippine studies about indigenous games from various backgrounds (Aguado, 2012; Barbosa, 2014; Carmen et al., 2015) revealed local games that are being practiced by various localities, thus revealing its similarities and differences to the Ivatan indigenous games. Interestingly, despite having similarities, the Ivatan games have their own unique game mechanics, number of players, and materials or instruments to be used when compared to their counterpart in other places. Historically, as mentioned by Carmen et al. (2015), the traditional games in the country were integrated into the curriculum of physical education, and sports activities of the Local Government Units (Senate Bill 1108 [Villar, 2010] and House Bill 2675 [Arroyo, 2013]) which is also observed in the province of Batanes up to this day during the conduct of the annual Batanes day celebration. However, with the advent of technology and the younger Ivatan generation being open to modern advancements, the Ivatan game culture is slowly threatened to be forgotten.

Ivatan indigenous games have the potential for innovating culture-game-based physics education to provide more instructional materials, help improve students' understanding, attitude, motivation, scientific sublime, and to help preserve

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the Ivatan culture by passing it down to the next generation. Furthermore, connecting these gaps in a managerial perspective, sustaining Ivatan indigenous games with intentions associated to the rationale of 1987 Philippine Constitution, Article XIV, Sec. 14 (Trillanes IV, 1994). The preservation, enrichment, and holistic evolution of a Filipino National Culture can be attained by developing projects such as crafting innovations such as integrating culture to instructional materials which can be aligned to the Annual Implementation Plans of schools, thus, the success of its continuity, funding, and adoption of such project may be appropriately monitored and managed, leading to a well-execution of a project.

FRAMEWORK

This study encourages to reintroduce the Ivatan indigenous games to learners, with the expectations of preserving the Ivatan indigenous games and traditions. The idea of the game-based learning module came from the Progressivist philosophy of John Dewey and Johan Pestalozzi (Ashman, 2017; Hayes, 2006), corresponding ideas about Ivatan culture, customs, and traditions by Dr. Cesar A. Hidalgo and Dr. Florentino Hornedo (Esteban and Valientes, 2019; Hidalgo, 1996; Hornedo, 2000; Veld, 2014), and Senate Bill 1108 (Villar, 2010) and House Bill 2675 (Arroyo, 2013) of the Republic of the Philippines. The developed game-based learning module was set to determine its effectiveness on the following:

Understanding

Students' lack of understanding in learning general concepts in physics is a significant factor in their conceptual attainment attributed to the nonexistence of real-life examples in curricula experienced by the learners (Arslan and Devecioğlu, 2010). For a learner to fully understand the scientific knowledge presented to them, educators must prepare and implement learning activities that promote thinking, discussing, interpreting, and relating each topic to real-life phenomena and experiences (Arslan and Devecioğlu, 2010). Furthermore, based on Dale's cone of experience (Lee and Reeves, 2007), which describes a group of experiences arranged according to the degree of abstraction, it is said that people, most especially learners, retain as much as 90% of what they do, this includes simulations, experiments, creating models, immersing oneself to real-life experiences, and designing and performing a presentation. Therefore, to develop a deeper understanding and more retention of fundamental physics concepts, students must be presented topics involving day-to-day situations and strengthen the scaffolding of concepts by immersing them into various experiments and situated cognition/knowledge in real-life circumstances (Redish, 1994).

Attitudes

Attitudes in learning refer to feelings, reactions, and beliefs toward the subject which are not innate characteristics of a student (Olufemi, 2012). Attitudes are considered to explain regularities and behavioral responses since it is considered to vary among individual learners (Adewuyi, 2006). Furthermore, attitudes are responses of each individual presented to them, such as concepts about the nature of physics and how they acquire knowledge (Adams et al., 2006). They may change over time (Erdemir et al., 2009) based on other people's experiences, concept attainment, skills, and responses to particular situations (Badeo, 2019). According to Dagnew (2007), attitudes are the best predictor to estimate students' success and achievement. Moreover, attitudes have shown to affect how students learn and what they want to learn; thus, helping students attain favorable attitudes, which can foster their understanding of a subject (Sahin, 2009). There has been research conducted over the past 40–50 years (Dorier and Garcia, 2013) with regards to attitude and how it plays as a factor in learning toward science/physics and its relationship to student achievement (Broggy and McClelland, 2009; Dorier and Garcia, 2013; Salta and Tzougraki, 2004). According to Osborne et al. (2003), attitude toward science/physics consists of different sub-constructs which eventually give rise to a person's interest and belief in learning the subject matter, as Chu et al. (2008) agreed to the aforesaid statement that with attitudes toward learning physics, it is a huge factor that influences their study habits, which is related to their conceptual development.

Motivation

Motivation drives people to work harder to reach their goals and aspirations (Duque, 2018). For a learner, it is merely the excitement, direction, and continuity of a certain behavior inside the classroom or toward a subject (Franken, 2006; Huitt, 2011). However, in education, motivation is very difficult to measure (Mubeen and Reid, 2014). One of the suggested keys to measure motivation is to look for behaviors indicating high or low motivation (Mubeen and Reid, 2014), through direct observation, attitudes, and inferring from overt behavior of a learner (Reid, 2006). Motivation toward learning can either be intrinsic or extrinsic (Guido, 2013; Tarver, 2020). Mubeen and Reid (2014), see intrinsic motivation as the inherent tendency to connect the interests of learners to their development and use these developed capacities for the benefit of each individual. Meaning, it represents the yearning of a learner to learn concepts like in physics, thus being able to understand it more profoundly and exhibits persistence to learn it (Ryan and Deci, 2000). Furthermore, intrinsic motivation, as defined by Glynn et al. (2011) is the natural contentment of students in learning physics. It allows opportunities for them to freely select their learning goals and how to achieve those set standards; it fosters curiosity, aiding them to develop plans on how to pacify their questions; and it also allows learners to see meaningful learning by extracting its values and benefits, whether the tasks are attractive or not (Ames, 1990; Marshall, 1987; Mubeen and Reid, 2014).

Scientific Sublime

John Dewey's notion of aesthetic experiences paved the way to include affective qualities and aesthetics in science education, which Cavanaugh (2014) coined it the "science sublime" or "sublime science." Cavanaugh (2014) added that

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this unexplored area of science and arts is an integration of thinking and feeling that exemplifies the highest forms of aesthetic experience (Root-Bernstein and Root-Bernstein, 1997). Moreover, these esthetic experiences called sublime were then distinguished into three types, namely: The extreme sublime, connective sublime, and the scientific sublime.

METHODOLOGY

Research Design

This research study employed quasi-experimental research design as it focused on the effect of the pedagogical intervention. Specifically, the development of the game-based learning module utilized the Analysis – Design – Development – Implement – Evaluate (ADDIE) model. This model is a scientific problem-solving process which emphasizes instructional design process, such as this study's researcher developed innovative intervention integrating Ivatan indigenous games with physics concepts. The first four phases of the ADDIE model were used to construct the innovative intervention where it underwent the process of analyzing the least mastered competencies and the fitting of games, design, and development of the game-based learning module, and validation – pilot-testing – revision of the developed module. The last part of the process which was the evaluation phase which aimed to determine its effectiveness on students' understanding, motivation, attitudes toward learning, and scientific sublime utilized the slices of the journal as data to triangulate the quantitative findings. The purpose of this research design was to provide an analysis of the research problems by triangulating the quantitative and qualitative data. The researcher collected quantitative (pre-test and post-test) data to describe the changes on learners' understanding, motivation, and attitudes toward learning physics and qualitative (journal entry) data to describe their scientific sublime levels, within a single study on a similar time frame while prioritizing them equally, keeping independent data analysis, and merging the obtained results during the general interpretation while looking for possible relationships between the two forms of data.

Research Site and Participants

This study was conducted on a public high school in Batanes, Philippines. The participants were twenty (20) homogenous Grade 11 Senior High School students enrolled for the 2020–2021 school year with an age range of sixteen (16) to eighteen (18) years old. All twenty (20) participants are Ivatan (Batanes indigenous people) in ethnicity and voluntarily agreed to participate in the study after securing the parents and the students written consent, guaranteeing the confidentiality of the gathered research data to protect their privacy. Further, purposive sampling was employed in this study since the respondents are under the Science, Technology, Engineering, and Mathematics, and the developed material was based on the learning competencies of the General Physics course for the STEM strand. Four (4) experts were selected to validate the developed game-based learning module: (1) A doctor in physics-education and culture expert from Philippine Normal University – Manila, (2) two doctorate students specializing in physics education from De La Salle University – Manila and Philippine Normal University – Manila, (3) and a retired Science Supervisor from the Department of Education Division of Batanes. Finally, three (3) experts were chosen as co-raters and validators on the data analysis part: (1) Two mathematics teachers both with master's degree in Mathematics education and Educational Management, respectively, (2) and a Registered Professional Psychologist and Psychometrician with two master's Degrees.

Instrumentation

The validating instrument for the developed learning material was based on the study of Pantig (2012). It is a criterion-based reference tool that was modified based on the features of the developed learning material. The material was assessed based on Content, Language, Layout, Illustrations/Figures, Other features, and Overall presentation of the module.

Understanding

A paper and pencil test was used to measure students' understanding. It was composed of thirty (30) items, along with its table of specifications adapted and contextualized from other research studies such as force concept inventory, force motion concept evaluation, and conceptual questions by Hewitt (2014). The 30-item paper and pencil test were initially pilot tested to randomly selected Senior High School students of the same STEM strand which consisted of the same characteristics to the intended actual respondents to determine the validity of the items included by calculating its point-biserial correlation coefficient. Results of the R_{pbi} revealed to revise the thirteen out of thirty questions. Furthermore, the reliability of the thirty-item test revealed a Cronbach's alpha value of 0.760 which was interpreted as "acceptable" (Glen, 2021).

Motivation

Physics Motivation Questionnaire II (PMQ-II) by Glynn et al. (2011) was utilized to measure students' motivation. It was administered as a pre-post-test type. It is composed of 25 item Likert-type instrument, ranging from 1 to 5, having corresponding verbal interpretations of never, rarely, sometimes, often, and always, respectively. In addition, the PMQ-II was translated to the Ivatan language by an Ivatan language expert from the National Commission for Indigenous Peoples, who was also a retired schools division superintendent in Batanes and an incumbent indigenous peoples mandatory representative to the provincial government. The analysis results of the translated instrument yielded an overall validity value of 0.507, which was interpreted as "very high" validity coefficient (Drummond and Jones, 2010), and a 0.852 reliability value which was interpreted as "good" reliability (Glen, 2021).

Attitudes

Colorado learning attitudes toward science survey (CLASS) by Adams et al. (2005) was used to probe students' attitudes toward learning physics. It was administered as a pre-post-test type, comprised 42 item Likert scale instrument, ranging from 1 to 5, with corresponding verbal interpretations of strongly disagree, disagree, neutral, agree, and strongly agree. Like the motivation questionnaire, the CLASS instrument was also translated to the Ivatan language by the same expert. The validity and reliability values were 0.413 and 0.894, respectively. Based on Drummond and Jones' (2010) interpretation in terms of its validity, the translated CLASS was deemed to have a "high" validity, while having a "good" reliability based on Glen's (2021) interpretation.

Scientific Sublime

Sets of questions through journal type were attached to the game-based learning module to be answered by the respondents every after the conduct of the activity. The questioning was based on their feelings/emotions that describe the learner's scientific sublime. Furthermore, the set of questions were content validated by a professional psychologist.

RESULTS AND DISCUSSION

Validation of the Game-Based Learning Module

The game-based learning module integrating physics to Ivatan indigenous games was developed and validated by four experts. This collection of activities featuring eleven indigenous games was rated as "Highly Acceptable" by the validators. Also, the mean value of the inter-rater reliability coefficient (Fleiss Kappa) on the validators' ratings was considered "Good Agreement." These results indicate that there was a high level of agreement and acceptability among experts who validated the developed game-based learning module which agrees to several studies (Mercado, 2020; Ocampo et al., 2015; Pastor et al., 2015; Rogayan and Dollete, 2019). Furthermore, the provided feedback by the expert validators anticipated the possible benefits of the developed game-based learning module once applied to the teaching-learning process.

Moreover, Nunan's (1989 as cited in Rogayan and Dollete, 2019) specified that developed materials are considered good if they meet the following criteria: (1) Topics included are connected to the curriculum; (2) validity in terms of task to be performed; (3) the developed material stimulates interaction among the learners; (4) allow the student's to concentrate on the learning aspect; (5) encourages them to develop skills in learning, and (6) apply their developed skills in real-world situations. The evaluation results imply that the developed game-based learning module still has areas for improvement, yet good enough to be utilized as a supplementary instructional material to teach the selected topics in the physics subject such as distance and displacement, newton's laws of motion, momentum and impulse, projectile motion, uniformly accelerated motion, and other competencies included in the module.

Game-Based Learning Module's Effect on Students' Understanding

The respondents' mean score in the pre-test is 14.95 (Table 1), and with a relatively lower standard deviation value of 2.31 compared to the post-test mean score value of 17.60, and a standard deviation of 3.38. These values show that the scores obtained were closer to each other relative to the mean. On utilizing the game-based learning module to the students, it yielded an increase of 2.65 points in the overall mean scores. Using the game-based learning module could significantly improve the students' understanding despite the sample size having more spread and lesser reliability in standard deviation and standard error mean, respectively. The high values of standard deviation and standard error mean on the post-test can be attributed to some learners gaining extremely high scores relative to other learners, while others either retained or slightly increased or decreased their scores.

Observing the outcomes in the comparison between the obtained pre-test and post-test scores, it can be clearly stated that there is a significant difference in students' understanding of learning physics, proven by the 0.008 Sig. (2-tailed) the value indicated above. Furthermore, the small effect size of 0.31 (Cohen, 1998) supports the claim, that for every five students who received the intervention, around 58% or at least three students understood the concepts tackled, which are supported by an increase in their scores.

The significant increase in students' understanding was similar to other research findings (Almario, 2002; Auditor and Naval, 2014; Bayle, 2004; Vega, 2004) where learning materials that were validated to be highly acceptable among experts effectively increase student's content-knowledge acquisition. In addition, Leonen (2016) confirms that the use of designed learning instructional materials improves students' performance which further strengthens conceptual attainment through confirmation and clarification of the tackled lessons.

The small effect size of the game-based learning module on students' understanding was further confirmed by Petty's (2009) study on evidence-based teaching, the average effect of an innovation is said to have a value higher than 0.30 proving that the game-based learning module works as intended.

Table 1: Change in student's understanding of physics concepts

Test	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)	Cohen's d
Pre	14.95	2.31	0.52	-2.95	19	0.008	0.31
Post	17.60	3.38	0.76				

N=20 Level of significance=0.05

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The small effect size on students' understanding may be attributed to the limited amount of time the intervention was utilized, regardless, it still led to the improvement in learning as it was applied thoroughly; thus, the effect size value of the game-based learning module being above average value proves it otherwise. This result correlates to McLeod's (2019) interpretation of effect sizes; an obtained value higher than 0.2 means at least 58% of the total sample size before the intervention's utilization is lower relative to the mean after its implementation.

Furthermore, the obtained value of the effect size is equivalent to confirmed working and proven pedagogies such as gaming/simulations, cooperative learning, and student-centered teaching which may likely to impact student achievement positively and has the potential to accelerate learner achievement (Hattie, 2018). Furthermore, these results agree with Popov's (2008) study, which revealed that outdoor physics activities cause deeper thinking, allowing better knowledge and understanding of concepts and methods as the activities in the topics being tackled could be experienced with different senses. Learning physics in a traditional game-based setup allow students to explore the physical phenomena in the realistic situations of their daily life, thus, promoting better conceptual attainment.

Game-Based Learning Module's Effect on Students' Motivation

Table 2 shows an increase of 0.91 in the mean scores in students' motivation after implementing the game-based learning module. The standard deviation and standard error mean yielded an observable lower value upon the intervention's utilization. This means that after its implementation, the learners' responses were more positively oriented, increasing the overall responses and more homogenous relative to the mean. This increase is significant given by the Sig. (2-tailed) value of 0.000, with an effect size of 0.86. The presented values mean a significant effect in the utilization of the game-based learning module on students' motivation with a large effect size (Cohen, 1988).

The significant increase in students' motivation can be related to Guido's (2013) statement that students tend to be more motivated when the concepts they learn are relatable and deemed useful to the learner's everyday life experiences. According to Pesare et al. (2016), engagement is seen to be firmly associated with their motivation. This indicates that the game-based learning module successfully motivated the learners as it supported experiential, multi-sensory, active, and problem-based learning, promoting direct recovery of schema and providing immediate feedback (Papastergiou, 2009 as cited by Pesare et al., 2016). Furthermore, the results on the application of the developed game-based learning module also agreed to Holubova's (2015) findings where teaching science requires teaching learners the creativity, exploratory skills, and application to real-life phenomena which will help improve to the success of learning and teaching of it. This indicates that after utilizing the Ivatan game-based learning module, the increase in their motivation in learning physics were observed since: (1) Their perception of physics they learn became relevant to their lives, (2) the fresh approach in learning physics made it more interesting, (3) they enjoy learning physics due to the games included, (4) it made more meaningful real-life connections, and (5) developed a curiosity about the discoveries in physics through the concept of play. It should be noted that despite the limited time in implementing the game-based learning module with the students, these reasons may be attributed to the large effect size on students' motivation in learning the subject.

Game-Based Learning Module's Effect on Students' Attitudes

The mean score obtained from the respondents in the pre-attitudinal survey is 2.97 (Table 3), with a standard deviation value of 0.22 with its corresponding standard error mean value of 0.05 compared to the higher post-survey mean values of 3.41, a lesser standard deviation of 0.17, and standard error mean value of 0.04. Furthermore, there is an increase of 0.44 on the overall mean scores with a slightly lesser spread in standard deviation, yet a negligible difference in standard error mean. This means that the mean increase on the pre and post-attitudinal survey is considered significant based on the Sig (2-tailed) value of 0.000 and a medium effect size value of 0.777 (Cohen, 1988).

Table 2: Change in student's motivation towards learning physics

Test	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)	Cohen's d
Pre	2.98	0.32	0.07	-10.8	19	0.000	0.86
Post	3.89	0.19	0.04				

N=20 Level of significance=0.05

Table 3: Change in student's attitudes towards learning physics

Test	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)	Cohen's d
Pre	2.97	0.22	0.05	-8.14	19	0.000	0.78
Post	3.41	0.17	0.04				

N=20 Level of significance=0.05

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There are eight attitudinal domains under the attitudinal survey, divided into favorable and unfavorable responses. Favorable responses by the learners are considered having the same attitudes to that of a physics expert while unfavorable responses are of the opposite, set by Adams et al. (2006). Furthermore, the pre-and post-responses of the learners to the attitudinal questionnaire were transmuted through an excel program coded by the author of the instrument, to arrive at the presented favorable and unfavorable responses per domain for their attitudes toward learning physics.

The real world connection yielded the most notable effect size among the eight attitudinal domains with a value of 0.42 (Table 4). Other notable large shifts as the intervention were utilized was their conceptual understanding, applied conceptual understanding, and problem solving sophistication.

This is similar to Smidt et al. (2014) findings that interaction among learners and designing creative and innovative creative tasks to address multiple learning styles help in improving their attitudes. This means that use of the game-based learning module yielded favorable attitudes as they (1) saw the connections of topics in physics to their day-to-day experiences, (2) developed skills that were helpful outside the classroom (Adams et al., 2006; Garcia et al., 2013; Mistades et al., 2011), and (3) were able to see things in a more complicated perspective. The medium effect size may be attributed to the reason that among the eight domains that are under attitudes, only the four domains of Problem-Solving Sophistication, Conceptual Understanding, Applied Conceptual Understanding, and Real-World Connection yielded a notable shift. This implies that the use of the game-based learning module notably affects these domains; also, it may be influenced by the duration of the application of the intervention (Duque, 2018). Furthermore, the application of a game-based learning instruction by White and McCoy (2019) reveals that many of the students' negative attitudes toward learning a topic were observed to be lessened or improved. This implies that student engagement to gamified physics activities improved their attitudes in learning physics since they are able to directly connect it to their environment and real-world scenario reduces their perception on the complexity of the subject matter through playing games, which then ultimately results to improving their attitudes that they are able to understand the concepts tackled.

Relationship between Students' Understanding, Motivation, and Attitudes

The relationship between understanding and motivation had a significant moderate uphill relationship having a value of 0.651 (Table 5) (Rumsey, 2016). This finding was validated by the study of Leong et al. (2018), which stated that analyses of data in a cross-country set-up support the current motivation theory in learner performance in academic achievement, which further states that higher motivation in learning leads to higher achievement scores. This means that enhancing the motivation of learners to learn based on the domains presented such as intrinsic, self-efficacy, self-determination, and extrinsic motivation, that is, grade and career through game-based learning maximizes their interest in learning physics thus resulting in better conceptual attainment. Furthermore, it can be implied that applying the intervention as a supplementary teaching material may increase their understanding of the topics in physics by motivating them by letting them be exposed to Ivatan indigenous games due to the fact that based on the results, there is a moderate uphill relationship between understanding and motivation. This considers that if motivation decreases, the understanding also decreases, or vice versa, similar to Yarin et al. (2022) study, finding out a positive correlation between the dimensions of learner academic performance and their motivation toward learning a subject.

The correlation between students' understanding and their corresponding attitudes toward learning physics as shown below also yielded a strong uphill relationship with a value of 0.828 (Table 6) (Rumsey, 2016). The results were similar to Cahill et al. (2018) who claimed that learners' attitudes related to how much students perform and learn in their class. Furthermore, Mushinzimana and de la Croix Sinaruguliye (2016) stated that the poor performance of learners studying physics was attributed to their attitudes which play a big role. This correlation paves the way as researchers seek to improve attitudes of learners toward learning physics to improve their performance. Studies revealed students who have low self-esteem or attitudes are the ones most likely to have poor achievement in learning (Leroy and Bressoux, 2016; White

Table 4: Favorable and Unfavorable Attitudes of Students towards learning Physics

Attitudinal Domains	PRE		POST		SHIFT		Cohen's d
	Fav	Unf	Fav	Unf	Fav	Unf	
Personal Interest	49.2	34.2	52.5	25.8	3.3	-8.3	0.20
Real World Connection	52.5	32.5	48.8	28.8	-3.8	-3.8	**0.42**
PS General	43.8	36.3	45.6	30.0	1.9	-6.3	0.25
PS Confidence	41.3	40.0	41.3	33.8	0.0	-6.3	0.20
PS Sophistication	42.5	44.2	40.0	29.2	-2.5	**-15.0**	0.00
Sense Making/Effort	36.4	37.9	40.0	35.7	3.6	-2.1	0.38
Conceptual understanding	30.0	54.2	39.2	30.8	9.2	**-23.3**	0.12
Applied Conceptual understanding	32.1	51.4	36.4	32.1	4.3	**-19.3**	0.07
Overall	39.6	41.0	39.7	35.0	0.1	-6.0	0.78

N=20

Table 5: Correlation between Students' Understanding and Motivation

	Post-Motivation
Post-Test	
Correlation Coefficient	0.651**
Sig. (2-tailed)	0.002
N	20

**. Correlation is significant at the 0.05 level (2-tailed).*
***. Correlation is significant at the 0.01 level (2-tailed).*

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and McCoy, 2019), which describes the attitude – conceptual attainment correlation. This means that supporting students through exposing them in innovative pedagogies such as the use of the game-based learning module may improve their attitudes in learning physics which leads to better understanding of the subject (Sahin, 2009). Since, students' understanding can be attributed to their attitude as it affects their degree of information retention (Garcia, et al., 2013; Guido, 2013).

Moreover, Akinbobola (2009) revealed that cooperative learning when introduced to students increased their attitudes toward learning physics, Marušić and Slisko (2012) noted that active learning also increases learner attitudes. These studies support that the developed game-based learning module fits the criteria of encouraging cooperative learning among students and promotes active learning, indicating that it improves students' attitudes thus also affecting their understanding of physics.

Correlating the motivation and attitudes of the students as shown on table below after the utilization of the game-based learning module revealed a 0.718 r-value (Table 7), which is interpreted to have a significant moderate uphill relationship (Rumsey, 2016).

This study's results have a significant correlation to Guido's (2013) study which stated that there is a high to very high positive uphill relationship between motivation and the attitudes of students. This means that as motivation increase, their attitude increases. Immersing students in varied learning styles such as the gamification of the physics concepts through the Ivatan indigenous games improved their attitude toward learning physics which also influenced their motivation (Guido, 2013), further implying that students who have higher motivation tend to participate or engage in class also displayed favorable attitudes toward the subject. Furthermore, it agrees to Cracker's (2006) statement that positive attitude affects achievement and the notion that learners who have a positive attitude toward and motivation in learning physics will achieve better.

This study highlights that relationship among the three variables: understanding, motivation, and attitudes toward learning physics were correlated. This finding showed that attitudes toward learning is considered to be a key factor in the motivation of learners since they were directly correlated (Guido, 2013; Cracker, 2006) which consequentially affects their understanding of the subject (Bidin et al., 2009). This signifies that through the utilization of the game-based learning module, improving the attitudes of the learners and motivating them affects their understanding of the subject.

Table 6: Correlation between Students' Understanding and Attitudes

	Post-Attitude
Post-Test	
Correlation Coefficient	0.828**
Sig. (2-tailed)	0.000
N	20

**. Correlation is significant at the 0.05 level (2-tailed).*
***. Correlation is significant at the 0.01 level (2-tailed).*

Table 7: Correlation between Students' Motivation and Attitudes

	Post-Attitude
Post-Motivation	
Correlation Coefficient	0.718**
Sig. (2-tailed)	0.000
N	20

**. Correlation is significant at the 0.05 level (2-tailed).*
***. Correlation is significant at the 0.01 level (2-tailed).*

Students' Scientific Sublime

The most common feedback solicited from the students upon utilizing the game-based learning module was the very strong feeling of happiness with some sentiments of nostalgia, some representative statements (all names are pseudonyms):

> *Happy to learn new things and be able to do activity related to our childhood* (*Justin, 17 years old*)
> *I was amazed it felt like all* (*old*) *times because the concept was like playing marbles* (*Sam, 17 years old*)
> *Good since after a long time, I was able to play with my friends even with an unfamiliar game. I was able to reminisce my childhood days playing under the sun* (*Jam, 17 years old*)

These results may not mean that the students are longing to play the traditional games again due to the limited responses, however, it implies that the use of Ivatan indigenous games in learning modules in physics may trigger positive feelings based on students idealized memories which consequentially affects their motivation and attitudes toward learning the subject, eventually affecting the learners' understanding of the subject. Furthermore, these results support Bringula et al. (2015) study where they found out that emotions such as being very happy, excitement, and delight dominate other forms of emotions when playing games.

Research (Chen et al., 2020; Hung et al., 2014; Wichadee and Pattanapichet, 2018) regarding game-based learning instruction revealed that it is more preferred than the conventional instruction in evoking interest, involvement, confidence, and enjoyment (Chen et al., 2020; Garris et al., 2002). This means that the developed game-based learning module triggered positive experiences through collaborative learning in physics, and helped maintain students' positive emotions or feelings, and aid in the facilitating the low performing students' conceptual attainment. Concurrently, the predicted "Extremely Amazed/Overwhelmed" feedback only generated a response rate of five percent of the total learners. This result may be attributed to Cavanaugh's (2005) explanation that in order to foster scientific sublime experiences, an effective model or content highlighting the sublime must be done This means creating situations that are intense which consequentially arouses astonishment, overwhelmed, awe, fear of danger, obscurity, and terror. However, the aforesaid statement

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contradicts to the nature of the game-based learning instruction since the module itself promotes different forms of emotion toward learning the subject. With these, it can be implied that fostering the feeling of sublime through the developed game-based learning module may not be enough to trigger extreme emotions such as being amazed, astonishment, overwhelmed, awe, fear of danger, obscurity, and terror.

CONCLUSIONS

The highly acceptable evaluation corresponded with good agreement among the four validators indicates that the integrated Ivatan cultural games to physics game-based learning module was ready to be used as supplementary instructional material to teach physics concepts. The natural environment and cultural game-based instruction provided authentic and meaningful learning opportunities. However, it takes a large amount of effort in preparation and execution to provide productive learning outcomes. Introducing the concept of play infused with physics concepts leads to better understanding, promotes engagement leading to more motivated and eager learners, and more favorable attitudes toward the subject. This indicates that the introduction of innovative pedagogies utilizing real-world conditions can address learning gaps and produce better learning outcomes. Innovative learning materials that improve students' interests, encourages learner behavior may directly affect their understanding toward learning the subject. Continued testing of such material along with its validation and revision by incorporating new ideas and technologies should help in improving one's understanding toward the subject. Even though cultural game-based physics activities are very helpful as supplementary instructional material, it cannot be used as a standalone material to foster the experiences of scientific sublime; therefore, it was ineffective in developing extreme emotions or feelings. On the other hand, students who are immersed in culture integrated activities tend to feel extreme happiness and nostalgia, which may be a vital aspect in reminding the younger generation of one's culture and tradition. Therefore, integrating culture as part of their learning retains their curiosity and sense of exploration as they are continuously immersed directly and able to relate things to their environment. With these, they will be actively involved, followed by the development of cultural awareness, which then becomes a practice and be part of their daily living, therefore, leading to the preservation of the Ivatan culture. Overall, integrating Ivatan indigenous games to learning modules in physics is effective in improving students' understanding, motivation, and attitudes toward learning physics, but unsuccessful in fostering the scientific sublime.

Recommendations

The study aimed to test the developed and validated learning module as an intervention to improve students' understanding, attitudes, motivation, and foster scientific sublime toward learning physics. Specifically, the learning module integrated Ivatan Indigenous Games to physics and attempted to benefit the following:

1) Students, by utilizing the developed game-based learning material, it will support students to have a better grasp on the selected topics in physics, gain more favorable attitudes, motivate them in learning the subject matter, and will also help them realize the connection of not only physics but science as a whole in their everyday life. Ultimately, to reintroduce the Ivatan indigenous games to the new generation as they are on the verge of forgetting it due to technological advancements in society.
2) Teachers, using it as a supplementary teaching tool, it should help them to engage learners by immersing them in varied learning activities and should help in altering negative notions to shift to a positive one. This developed learning material may also increase student achievement and conceptual attainment as they apply their learned concepts in a fun and systematic way, thus, creating a more conducive teaching-learning process inside and outside the classroom.
3) The Ivatan community, with the innovated learning material, it may contribute to the preservation of the Ivatan culture through promotion, adaption and application of science and culture-based studies to socio-cultural gatherings and reflect that as they embrace societal changes such as growth and development, not to forget what defines this ethnicity an Ivatan.
4) Future researchers, this study should inspire others by bridging the gap of limited information in the locality with regard to the relationship of science, specifically physics studies and Ivatan culture; and to innovate strategies/modules from cultural beliefs and practices of the community, for preservation, and the advancement of the quality of education here in Batanes.

Research Ethics Protocol

Following the research ethics and standard protocol, the researcher first secured a letter of permission to the Municipal Mayor (head of the Local Inter-Agency Task Force) to conduct a limited face-to-face class for the data gathering since the province was categorized as low-risk community area, with the assurance of following strict health protocols to ensure their safety and security. On receiving the reply letter of the Municipal Mayor granting the request, another letter of permission was secured from the principal of the school to certify an agreement between the researcher and the principal. After settling an agreement from the Mayor and the Principal to conduct a limited face-to-face class, the researcher then sought the parent's consent, and students' agreement to participate in the study guaranteeing the confidentiality of the gathered research data to protect their privacy.

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