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Creativity: A Motivational Tool for Interest and Conceptual Understanding in Science Education

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***Abstract*—**This qualitative, quantitative mixed-method study explores how students' motivation and interest in creative hands-on activities affected their conceptual understanding of science. The objectives of this research include developing a greater understanding about how creative activities, incorporated into the classroom as instructional strategies, increase student motivation and their learning or mastery of science concepts. The creative activities are viewed as a motivational tool, a specific type of task, which have an impact on student goals. Pre-and-post tests, pre-and-post interviews, and student responses measure motivational-goal theory variables, interest in the activity, and conceptual change. Implications for education and future research will be discussed.

***Keywords*—**Science education, motivation, conceptual understanding, instructional strategies.

I. Introduction

TEACHERS use different instructional strategies or motivation tools such as cooperative learning strategies and inquiry-based learning to engage students, hoping to promote interest and increase the students' effort in learning the material [1]. Recent literature in science education indicates that there is a relationship between motivation, cognitive engagement, and conceptual change [2]-[3]. Motivation involves an individual's choice to engage or not to engage in an activity, persistence in the activity, intensity throughout the activity, and results in an increase in the quality of the activity [4]. Thus, motivation should be central in the development of any sound educational programs. This research will explore how students' motivation and interest in creative, curriculum-based, hands-on activities affect their conceptual understanding of science. The objectives of this research include developing a greater understanding about how creative activities, incorporated into the classroom as instructional strategies, increase student motivation and their learning or mastery of science concepts. The creative activities will be viewed as a motivational tool, a specific type of task, which should have an impact on student goals.

II. Background

California's secondary science curriculum promotes scientific literacy as a goal. The overall intention for science education is that all graduates of secondary schools will achieve excellence and a high degree of scientific literacy while maintaining a sense of wonder about the world around them. The science curriculum recognizes that science is a significant domain of study in the 21st century and is a subject that can be linked with many other disciplines. For students to develop scientific literacy, educational literature supports the approach that students must go through a process and a shift in understanding [3]-[5]. This shift is commonly seen as conceptual change and is necessary for conceptual understanding to occur.

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III. Theoretical Framework

Conceptual change refers to the reorganizing of current conceptual knowledge in the face of conflicting new information [3]. For a student to change their alternative framework of understanding, they need to have a dissatisfaction of their current concept, the new concept has to be intelligible and plausible, and finally, it must be fruitful [6]. This model provides an interesting premise on how an individual learner may change their understanding of a concept and outlines the importance of prior knowledge for this change to occur. If science teaching should provide a rational and accessible basis for conceptual change, it must provide an opportunity for students' prior knowledge to be heard and then create lessons that will shape students' understanding.

Conceptual change literature has now expanded the conceptual change model to include the influence of the individual's motivation for learning [7]. This has further implications for teaching science because not only must the teacher present a rationale for conceptual change, but the teacher should also increase the quality of the engagement. This increased quality of engagement should result in a better conceptual understanding for students.

Creating motivation within the science classroom can be challenging but is necessary for learning. Motivational theory has many dimensions. Goal theory identifies learning goals or learning goal orientation as important in the acquisition of conceptual understanding [2]. Goal theory looks at the goals that students choose and the goal orientation of the academic task [3]. This motivational theory has typically defined goals as "cognitive representations of the different purposes students may adopt for their learning in achievement situations" (pp. 93) [8]. Based on this theory, students who achieve mastery and performance of the activity have a higher goal orientation.

Learning goals, sometimes called task goals or mastery goals, focus on the mastery of the task. Generally, this type of student has a deep need to fulfill and complete the task. Performance goals focus on demonstrating one's competence and avoid the appearance of incompetence. This type of student is highly competitive and very ego-driven. Central to perceived instrumentality is the relationship between the school task or subject and the value of future goals. Finally, the motivation goal of pleasing the teacher, parents or peers is a variable of interest in current motivational literature because it does seem to have an impact on students' academic successes [3].

The final aspect of this research is creativity. "Talent may be defined as the application of creative thinking ability to a specific domain that results in a creative project, i.e., an actual product that is unusual and of high quality" (p. 304) [9]. Creative activities can be seen as a specific product or performance of an individual's talents or capabilities [10]. Although inquiry-based activities can also be creative, the use of other activities from the disciplines of art, drama, music and dance are generally not incorporated into the science classroom. Multiple intelligences such as linguistic, spatial, musical, bodily/kinesthetic, interpersonal and intrapersonal are largely ignored in the science curriculum [11]. Creative activities from the arts, drama, music, and dance disciplines within a science context would address these multiple intelligences. In addition, these activities could be used to motivate and encourage students' interest in science concepts such as astronomy.

IV. PURPOSE OF STUDY

It is the intent of this research to develop a better understanding of how creative, curriculum-based activities increase student motivation and their learning or mastery of science concepts. The creative activities will be viewed as a motivational tool, a specific type of task, which should have an impact on student goal orientations. It is predicted that creative, curriculum-based, hands-on activities will have an impact on students' motivation and interest in science learning. Through these creative activities (i.e., context-specific), students' goal orientation will increase and result in more effort and interest in the subject domain. Finally, this increased effort and interest will positively influence students' conceptual understanding of science and promote more positive attitudes towards science concepts and its application.

V. METHOD

A. Mixed Method Approach

A mixed-method approach was selected for this study because of the nature of the participants (secondary science students) and the educational environment (science classes). This method was developed in 1959 when Campbell and Fiske used multiple methods to study validity of psychological traits and many similarities exist between their project and this study (students' goal orientation) [12]. This approach allows for pragmatic knowledge claims such as motivational goal variables, i.e., learning goals - mastery of the task, are influenced by the task itself (the creative activity), and will increase motivation and affect conceptual understanding. It employs both open and closed-ended questions within semi-structured student interview and student questionnaires respectively. Using this type of methodology enables the researcher to utilize ideas from emerging (e.g., student concept responses for Earth and Space) and predetermined approaches (e.g., test items on questionnaires). The hypothesis statements as outlined earlier necessitate analysis that involves both quantitative and qualitative analysis of student interviews, responses, and student questionnaires.

The mixed-method model that is best suited for this project will be concurrent triangulation [12]. In this model, both qualitative and quantitative data are collected and analyzed at the same time, and this data is cross-validated to corroborate findings. The quantitative methods using the test instruments of pre-and-post questionnaires focus on goal orientation variables. These variables are seen as the independent variables and will be monitored for increases due to the task (creative curriculum-based activity). The dependent variable of conceptual understanding will be tested using pre-and-post questionnaires through the multiple-choice items. Another dependent variable is engagement in activity and this will be tested through the pre-post questionnaire test items. Qualitative methods will use the same independent and dependent variables to shape the interview guidelines and analysis of the student responses.

This study used a single-state, non-random, convenience-sampling procedure. Two ninth-grade classes from a single medium-size school (1000 students) in southern California participated in the study. These two academic science classes consisted of 41 students (N=41), 22 males (53.7%) and 19 females (46.3%). This percentage is representative of the male to female ratio in the school. The school population is diverse, ranging from Caucasian, Hispanic, Asian, and African American students. The participants ranged in age between 15 years to 16 years. The socio-economic background is predominantly middle class.

All students participated in the pre-post questionnaires and creative activities as a regular part of the curriculum. Nine students volunteered to participate in the semi-structured pre-post interviews. Three females and six males with varying academic abilities and from diverse ethnic backgrounds volunteered to be interviewed. They had a variety of different interests and hobbies. Out of these nine interviewed students, only four will be presented in this article. Selection of the four students was based on their gender, similar responses, and prior educational background. The four students' pseudo names are John, Charlie, Teresa, and Alexander.

B. The Procedure of the Study

First, the pre-interview and pre-questionnaire were implemented to students in both ninth-grade science classes. Then, the students were assigned the creative, curriculum-based activity. The two creative activities from Astrocreativity module were *Watching the Night Sky* and *Timelines*. After the completion of these creative activities, post-interviews and post-questionnaires were conducted.

1) Creative Curriculum-Based Activities

There are several reasons for using creativity as an instructional strategy: a) As an instructional method, it allows for open-ended tasks where students are in control of their own conceptual understanding; b) Creative curriculum-based, hands-on activities are a task that increases interest in science education; c) Creative activities explore multiple intelligences in a classroom environment; and d) Creative activities allow for increased creativity exposure for science students [1]-[13].

2) Astrocreativity

The module of creative activities in teaching astronomy was designed to increase interest and excitement within the grade 9 Earth and Space Unit. The approaches of the module address learning styles and multiple intelligences. The module covers the rationale for creative activities, misconceptions about astronomy, provides several lessons, activities, exemplars and assessment tools to be employed in the classroom. For the purposes of this study, two activities from the Astrocreativity module were chosen.

Watching the Night Sky is an open-ended activity where students would observe the night sky over several days, record position of celestial objects, determine relative positions through triangulation methods (taught in class) and document their findings. Their final product could be illustrated, for example, as a comic strip or poster drawing. This activity was introduced through a powerpoint presentation of night skies. These illustrations were from real photographs, paintings from Vincent van Gogh's (1889) - Starry Night, and digital images of the stars and space from the website www.m3f.org. The classroom discussions that followed commented on the process, knowledge and skills required for the images to be created as well as the medium chosen by the artists to express their ideas.

Next, sky maps of constellations were presented to the class and students were asked to draw several constellations they saw in the night sky at different times throughout the next few weeks and record the time and the date. Students were encouraged to use the Internet and other resources to observe images of the sky at that time of the year. In one of the drawing observations, they had to include a triangulation of a celestial object (that they saw), comment on the movement of the objects in the sky (if any), and finally describe the colors, brightness and size of the various celestial objects seen in the sky. The students had the option of presenting their understanding in any medium.

Timelines is an open-ended activity where students could present the idea on either a) the life of a star, b) the birth of solar system, and c) the birth of the universe. The presentation of their activity could be through journalism, newspaper and magazine article, storybook, choreography, interview or poster. Due to time constraints, students had the choice of doing only one of three timeline assignments. The students wrote a report or commentary on their experiences throughout the project, their rationale for the project and finally, an explanation of the topic to the others in the class. This activity was introduced through formal lecture style presentations on the life of the star, birth of solar system, and the birth of the universe The lessons included homework questions from the textbook as well as handouts that outlined the knowledge of the events and videos about the topic. The final student products and responses were assessed based on conceptual understanding content, artistic quality, and novel approach.

C. Instruments

1) Qualitative Method

This study relied on qualitative data obtained from pre-post interviews, student responses from pre-post questionnaires, and student creative curriculum-based activities. The pre-interview guideline questions examined students' background, prior informal and formal science experiences, goal orientation, learning styles, and conceptual understanding of Earth and Space. Examples of pre-interview questions were: What were some of the ideas you remember from the Earth and Space Unit learned from your elementary school days? During the night where does the sun go? Why do you think this is so? Do you enjoy a more visual presentation in science class? Why? Give examples where possible.

Post-interview questions probed further into students' goal orientation, their interest in science and in the creative activities, their learning style preferences and their understanding of the Earth and Space concepts based on the ninth-grade science curriculum. Some examples of the questions were: How would you compare your enjoyment of these lessons to your usual enjoyment of science class? Do you feel that you have developed a better understanding of the science topics from the creative activity? Why or Why not?

2) Quantitative Method

A 60-item close-ended pre-post questionnaire was designed to evaluated students' goal orientation, motivation, and conceptual understanding prior to the creative curriculum-based activities and at the end of the Earth and Space unit. The questions were developed based on the motivational goal theory [3]. The test items on the pre-post questionnaire were measured using a 5-point Likert scale.

The questions were intended to measure goal orientation variables and formed the categories for the various question items: learning goal (20 items), performance goal (13 items), pleasing the teacher (12 items), pleasing parents (4 items), pleasing peers (9 items), and perceived instrumentality (12 items). The goal orientation test items were designed to complement the interview guidelines questions. The questionnaire also included concept multiple-choice items about the Earth and Space and test items regarding students' engagement of the creative activities.

Pre-questionnaire and response questions assessed students' prior knowledge of science concepts and concepts about Earth and Space from ninth-grade science curriculum before the implementation of the creative activities. The post-questionnaire repeated the sections from the pre-questionnaire addressing goal-orientation variables. In addition, there were questions about the students' engagement in the two creative activities, concept multiple-choice questions from the Earth and Space unit. The engagement questions were developed to measure the students' enjoyment, perceived interest and participation in the creative curriculum-based activities. Along with the module lessons, more traditional lecture-style lessons also covered the scientific concepts, such as the constellations, the birth of a star, the birth of solar system, and the birth of the universe. There were several opportunities to show supplementary videos about these concepts.

VI. Data Analysis and Findings

A. Qualitative Analysis

Interviews were transcribed and coded using motivational goal orientation variables. The statements were summarized and clustered into themes of goal orientation, conceptual understanding (including prior knowledge) and engagement of activity [14]. Student responses and creativities were analyzed for the quality of work, creativity (defined as a novel approach), enjoyment (based on terms expressed by students) and conceptual understanding (based on terms stated by students such as Nebula Theory, constellation, and quarks). Since a deductive methodology was used [12], the open-ended, semi-structured interviews highlighted the test items from the student questionnaire so the categories were easy to match up from both qualitative and quantitative data sets. Key words and phrases such as relief, enjoyment, fun, learning for myself, were recorded, counted and grouped into motivational goal orientation categories, which were similar to the quantitative items in the questionnaire [14]. Goal orientation categories were then correlated with conceptual understanding statements and engagement statements. Cluster themes and ideas were highlighted and triangulated with other quantitative data to give validity, reliability, and findings. There are correlations between goal orientation variables and conceptual understanding, and engagement.

B. Quantitative Analysis

The questionnaires were analyzed using the Statistical Package for Social Science (SPSS 14.0). The total number of completed questionnaires data items (pre or post) were entered into the program was 41, for a response rate of 74.5%, which is considered acceptable for social science research [15].

The pre-post test items were grouped into motivational goal orientation variables, concept multiple-choice questions, and engagement questions as described earlier. This grouping was done using exploratory factory analysis. Using factor analysis, each goal orientation variable test items was grouped and item-total correlation, variance and mean were used to determine whether item should be removed. A high inter-item correlation ($r > .70$; N = 41) indicated high internal consistency and provided evidence that the scales were reliable for measuring goal orientation variables, conceptual understanding and engagement variables.

Pair *t* test was used to examine pre-test and post-test for goal orientation variables. In this study, it is expected that the mean difference between the sample tests will occur and predicts the direction of the difference ($u_2 > u_1$). Therefore, this *t* test will use a one-tailed significant value. The advantage of a one-tailed paired *t* test is that high t values are not required to reject the null hypothesis. The disadvantage of not using a two-tailed significance value is that t values that would have been significant are not because there is no predicted direction. Prediction of positive mean differences will have +t ratios and prediction of negative mean differences will have –t ratios.

C. Results of Paired t Test of Goal Orientation, Mean Scores, and Standard Deviation

Pearson correlation coefficient was used to test for any possible relationships between the various goal orientation variables, concept total score, and engagement variables. These relationships can be deterministic predicators for motivation and conceptual understanding based on $\alpha < .01$, with a degree of freedom of 36, expected r = .413. If the degree of freedom is 18, $\alpha = .01$, expected r = .561, and if degree of freedom is 23, $\alpha = .01$, expected r = .505. All significant relationships from the pre-questionnaire are identified as positive. Pre-learning goals had strong positive relationships with all goal orientations, similar to the literature [2] (with pre-performance r = .494; ρ = .002, with pre-perceived instrumentality, r = .592, ρ = .000, with pre-please teacher r = .432; ρ =.008, and with pre-please friend r = .624; ρ = .000). The strongest relationship seen was between pre-learning goal and pre-pleasing friend (r = .624; ρ = .000), which was unexpected based on the pre-post student interviews. Pre-performance goal and pre-perceived instrumentality (r = .624, ρ = .000) and pre-performance goal and pre-please teacher (r = .755; ρ = .000) had very high correlation values.

There is a strong positive relationship between pre-please parent and pre-please teacher (r = .651; ρ = .000). Ninth-grade students who are 15-16 years of age view their parents and teachers as similar authority figures and adults of their community.

Pre-performance goal and engagement Activity B (r = .545, ρ = .019) and engagement Activity A and Engagement Activity B (r = .521; ρ = .011) had positive relationships. All scores were examined for gender differences but no significant gender differences were observed. Strong relationships between post performance and post perceived instrumentally
(r = .542, ρ = .006) and post performance with post please teacher (r = .538; ρ = .000) were expected and in line with pre-test results

VII. Results and Discussion

A. Research Questions 1 and 2

Do creative, curriculum-based, hands-on activities increase students' motivation or goal orientation and interest in science learning? For this analysis, the goal orientation variables were reviewed from both qualitative and quantitative data. Comparing statements from the pre-and-post interviews, and pre-and-post questionnaire responses, it was clear that the creative, curriculum-based activities did have an impact on goal orientation. Most students felt they learned for themselves, indicating high learning goals orientation. The creative curriculum-based activities allowed these students to work independently on ideas that interested them. From their pre-interviews and pre-questionnaire responses, students showed that they preferred visual presentations or lectures that incorporated visuals and hands-on activities. This is illustrated in the student's comments: "I enjoyed the creative activity…because I could incorporate what I wanted in my own drawings and my own designs." Another student, Charlie, felt he got bored during regular lessons and felt more motivated during the creative activity. Both students' statements supported hypothesis one and two – creative curriculum-based, hands-on activities increased students' motivation and interest in science learning.

Enjoyment of the creative activities is an important aspect of engagement. If students demonstrated high levels of engagement without focusing on marks as an incentive, then the quality of their work increases [16]. All students interviewed felt that they enjoyed the creative activities and increased engagement. Students who completed the projects indicated that they had strong engagement in the activity and the quality of their work was evident. Hence, there is an agreement in the literature and the findings, which suggests that the creative curriculum-based activities motivated the students, decreased the boredom of a regular class lesson, and the activity was an incentive for the students [1].

Quantitative data supports the qualitative data, where paired *t* tests showed that learning goals, pleasing parent goals and pleasing friend goals had positive increases post-creative activity. In particular, learning goal orientation had a *t* test value of $t = 1.56$ (18); $p = .005$, approaching desired *t* test value of 1.783, and is seen to be the most positively influences by the creative curriculum-based activity.

From the data, other conclusions can be drawn. If creative activities, seen as a task, increases post-learning goal orientation seen with paired *t* test results ($t = 1.56$ (18); $p = .005$) then there could be an increase in other goal orientations because of the strong link seen through Pearson correlations values of pre-learning goal with all other goal orientations.

To a lesser extent, quantitative data shows that there is a positive increase in pleasing parent goals and pleasing friend goals, post-creative activity. The paired *t* test values for these goal orientations were very low and may be rejected for the null hypothesis. Both qualitative and quantitative data give no direction for this motivational factor influenced by creative curriculum-based activities.

Thus, based on qualitative and quantitative data hypothesis research questions one and two are addressed: creative, curriculum-based tasks increase learning goal orientation and interest in science education.

B. Research Questions 3 and 4

Did the increased motivation affect effort and interest in subject domain? Did this interest in subject domain affect conceptual understanding? This hypothesis looks at the predictive value of goal orientations for increased interest and conceptual understanding in science concepts. For this analysis, qualitative data and to a lesser extent quantitative data will be utilized.

Students John and Alexander show the strongest post-activity conceptual understanding of Earth and Space based on qualitative data. Their concept responses detailed terms such as "quarks," "photons" and specific temperature values (5432ºF core). From reviewing their post-interview and post-questionnaire responses, both students were strongly motivated, showing an increase in learning goal orientation post-creative activity. Their final creative product demonstrated a novel approach and quality of work.

Using Alexander's post-interview comments, a relationship is highlighted between learning goals, engagement with creative activity and conceptual understanding. He felt that he learned more through the creative activities because "there was research to be done and everything." He stated, "I already had a good understanding, but the creative activities enhanced it." These responses indicate that there must be general knowledge before creativity is implemented and in addition, time is crucial for creative products to be of quality [17]. Alexander commented about his interest in science class and his enjoyment of learning science concepts. His strong conceptual understanding could be linked to his interest in science. This post-goal orientation qualitative data linking interest in learning is supported in the literature [2].

Students who commented that they enjoyed the creative assignments can be described as active learners [18]. Active learning strategies enable students to be more engaged in activity and increase their conceptual understanding. In particular, students who made the effort to complete the assignments in detail stated that they enjoyed the activity and were better able to answer the concept related questions. Engagement of creative activity A and Engagement of creativity activity B were positively associated based on Pearson correlation values ($r = .521$, $\rho = .011$).

VIII. CONCLUSION

In science education, teaching methods favor rote learning and memorization. As a result, many science students view science as boring, distant, and demanding. Creative curriculum-based hands-on activities can be a motivation for the science classroom. Creative activities can be exciting and fun. It can make science more accessible for students in a control-free, risk-free environment. Furthermore, creative products can show creativity. Creativity is usually seen in the arts and art products, but it can also be observed in the sciences. A science creative product requires conceptual understanding of science, therefore; a natural link is made between creative products and conceptual understanding in science.

A. The Impact of Creative Activities and Motivation

Overall, students were interested and enjoyed the creative curriculum-based activities. They were more engaged in their learning process and made many comments that the activities were "fun" and "exciting." Motivational goal orientations, in particular, learning goal (for the task) did increase. There was a real sense of pride in the completion of their products, especially if they felt that their product illustrated a creative idea. A student's creative idea may not be seen as original or novel but it is significant. Creative products that incorporate music, dance, song, drama, and visual arts enable students to experience this creativity and this can be motivating.

Part of the motivating features of the creative imaginative activities outlined in this study was the risk-free and control-free approach taken. The use of creative activities did lend to a constructive approach within the classroom. Students felt that they were in control of the activity and had many choices in their learning process. Students were given the option of working in groups or not, they were left to present the information from both projects in a way that served their interest. Students worked in a medium of art that best suited their learning styles. For the *Timelines* activity, some students chose to role-play an interview with a scientist, some students did a report style project and others chose a poster display. Students were given a flexible time frame to hand in the project (within the five-week period) and were given the opportunity to change and improve ideas of their products.

The success of the creative curriculum-based, hands-on activities was in part due to the fact that it met all of the characteristic properties for a creative product. Johnson-Laird [19] outlines these characteristics: (a) They were novel for the individual who creates them; (b) The choice was made from among options that are specified by criteria; and (c) They reflected the individual's freedom of choice and accordingly are not constructed by rote or calculation, but by a non-deterministic process.

B. The Impact of Motivation through the Creative Activities and Conceptual Understanding

The connection between conceptual understanding and mastery of science concepts is seen in some of the post interview responses and questionnaire responses. Literature shows that creativity requires general knowledge as well as disciplined mastery of the basic elements of special fields [17]. General science knowledge was crucial in the creation of quality products that showed conceptual understanding and for students to gain further understanding of the science concepts. Students who had a good understanding of Earth and Space concepts taught during class prior to the activity were able to create products and reinforce their knowledge. Students who had a weak understanding of the Earth and Space concepts did not gain further knowledge through the creative curriculum-based activities and in fact reinforced their misconceptions about the science concept.

C. The Impact of Parents, Teachers, and Peers

Parental and teacher motivation has an important role in the education of students. The evidence suggests that students in ninth grade have a strong desire to please first their parents, and second their teacher. This is supported in both the quantitative and qualitative data presented in this research. The use of parents and teachers as motivating factors is implicit within the education system today. It needs to be more explicit. Adolescents are often portrayed as rebellious by society as they struggle for their independence. Behind this image, adolescent students are shaped by parental and teacher mentors. Parents influenced students' thoughts on the importance of learning and how to learn. Furthermore, the teacher impact is one that needs to be explored more.

IX. Limitation to Research

From the literature, the design of the activity should have interactive assessment, test misconceptions, students should be able to self assess previous work and present work, and the rubrics for creative activities must be consistent and not task specific [20].

Assessment tools for creative activity and conceptual understanding could have been more effective. Assessment tools have to assess specific learning from the curriculum (check-list) so the students can focus on these ideas, make their own mental representation of this concept.

The activity was open-ended but needed more structure and design to reflect the concept itself. Assessment tools are essential and critical for changes in conceptual understanding to occur because this is the feedback students require to gage their knowledge and the new knowledge they are obtaining.

X. Educational Implications and Future Research

Effective instruction must give students the opportunity to question their beliefs and prior conceptions in a risk free environment. Creative activities provide this opportunity. The students must be presented the scientific theory that is plausible, intelligible, and fruitful, but students need time to developing their conceptual understanding through traditional formal science lessons [21].

Creative curriculum-based activities, as an instructional and motivation tool is a viable way to incorporate more multiple intelligences into the classroom. The creative and imaginative activities are open-ended, allow students to explore their interests and be in control of their learning. This aspect of the activities is very rewarding for students and teachers. The creative activities provide a learning environment that can influence goal orientation.

The influence of parents and teachers has huge implications for learning and planning curriculum. Creative curriculum-based activities are accessible for science teachers to use especially in covering topics such as Earth and Space, which do not lend to experimental approaches. Furthermore, since parents are a strong motivator for students' academic achievement, then creative activities make science more accessible to parents. Science educators should advocate for parent-student programs for secondary science to be developed.

Creative activities are one type of approach for creating a motivating, enriching learning opportunity for students. It has drawbacks for some students, such as students who are afraid of taking risks in their learning environment. However, creative activities do provide an option for the classroom science teacher. The learning environment as a whole should be further investigated to establish how the teacher, parent, and student could create an optimal learning environment. Based on this research, it is recommended that educational research continue to explore how successful learning environments influence students' goal orientation, their effort, quality of their engagement, and how this could eventually produce science students who better understand science.

References

[1] A. Taylor, "Learning science through creative activities," *School Science Review*, vol. 79, No. 286, pp. 39-46, 2007.

[2] S. Alao and J Guthrie, "Predicting conceptual understanding with cognitive and motivational variables," *The Journal of Educational Research,* vol. 92, No. 4, pp.243-255, 2000.

[3] T. DeBacker and M. Nelson, “Motivation to learn science: Differences related to gender, class type and ability,” *The Journal of Educational Research*, vol. 93, No. 4, pp. 245-256, 2005.
[4] M. Maehr, “Goal theory is not dead – not yet, anyway: A reflection on the special issue,” *Educational Psychological Review*, vol. 13, No. 2, pp. 117-185, 2003.
[5] D. Hodson, *Teaching and Learning Science*: *A Personalized Approach*. Philadelphia: Open University Press, 2002.
[6] P. Pintrich, D. Smith, T. Garcia, and W. McKeachie, “Reliability and predictive validity of the motivated strategies for learning questionnaire (MSLQ),” *Educational and Psychological Measurement*, vol. 53, pp. 801-813, 2003.
[7] P. Pintrich, R. Marx, and R. Boyle, “Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change,” *Review of Educational Research*, vol. 63, No. 2, pp. 167-199, 2004.
[8] M. Dowson and D. McInerney, “What do students say about their motivational goals?: Towards a more complex and dynamic perspective on student motivation,” *Contemporary Educational Psychology*, vol. 28, pp. 91-113, 2006.
[9] J. Leach and P. Scott, “Designing and evaluating science teaching sequences: An approach drawing up the concept of learning demand and a social constructivist perspective on learning,” *Studies in Science Education*, vol. 38, pp. 115-142, 2002.
[10] B. Phillips, “Can creativity be assessed/ Why not allow an experience to be its own reward and, if anything, reflection will naturally result?,” *Orbit*, vol. 46, pp. 407-441, 2002.
[11] H. Gardner, *Intelligence Reframed.* New York: Basic Books, 2005.
[12] J. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Thousand Oaks, CA: Sage Publications, Inc., 2006.
[13] R. Sternberg, *The Nature of Creativity*. Cambridge: Cambridge University Press, 2005.
[14] M. Miles and M. Huberman, *Quantitative Data analysis: A Sourcebook of New Methods.* London: Sage Publications, Inc, 2004.
[15] L. Aday, *Designing and Conducting Health Surveys: A Comprehensive Guide*. San Francisco, CA: Jossey-Bass, 2000.
[16] P. Hewson and M. Hewson, “The role of conceptual conflict in conceptual change and the design of science instruction,” *Instructional Science,* vol. 13, pp. 1-13, 2006.
[17] B. Woolnough, “Motivating students or teaching pure science?,” *School science review*, vol. 78, No. 285, pp. 67-72, 2005.
[18] M. Braud, “Electric drama to improve understanding in science,” *School Science Review*, vol. 81, No. 294, pp. 35-41, 2006.
[19] P. Johnson-Laid. *Freedom and Constraint in Creativity.* Cambridge: Cambridge University Press. 2006.
[20] G. Wiggins, *Educative Assessment: Designing Assessments to Inform and Improve Student Performance*. San Francisco: Jossey-Bass, 2003.
[21] G. Posner, K. Strike, P. Hewson, P., and W. Gertzog, “Accommodation of a scientific conception: Toward a theory of conceptual change,” *Science Education,* vol. 66, pp. 211-227, 2007.

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