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Original Article

Exploring the use of a Class Blog for PBL in K-12 STEM Subject

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Abstract *– As students in elementary schools through Secondary Schools (K-12) have difficulty Learning Science, Technology, Engineering, and Math (STEM) disciplines, their numbers enrolling in these disciplines in higher education are also decreasing. So Researchers are looking for news styles in education, including the use of Internet and Communication tools (ICT) to motivate students and enhance learning. Blogs are one of the ICT tools that could be used along with the use of Project-Based Learning (PBL) in the STEM discipline, for that matter. But there are certain aspects that need to be explored for a successful blending of class blogs along with PBL in a STEM discipline in order to give students more engagement and motivation.*

Keywords *– Blogs, PBL, K-12, STEM, Motivation, ICT, Formal Education, Teacher Efficacy.*

I. INTRODUCTION

There are were always challenges in teaching k-12 students STEM materials due to the scientific nature of these disciplines that require strong and deep thinking along with the ability to connect abstract concepts and relate to them. The number of students interested in these disciplines is falling (Hom, 2014). So the use of creative styles of education in regular school systems has many benefits. One of them is to keep students motivated. High school teachers always face a challenge to keep their students motivated (Lengye, 2010), so High school teachers must try to enable their students to succeed through the use of creative methods in order to motivate their students. By offering more choices to students, providing more authentic assessments, and allowing students to take an active role in their education, the Intrinsic Motivation of secondary school students will improve (Albrecht et al., 2012). PBL as project-based learning will enable students to collaborate with each other, apply prior knowledge, and gain different skills throughout the project. At the same time, STEM is an acronym for science, technology, engineering, and mathematics (Bell, 2016; Dugger, 2010). However, it means much more than the name itself (Ostler, 2012). Though, STEM education has the aim to teach these disciplines of science, technology, engineering and mathematics as one (Breiner et al., 2012). This means that students who are taught these disciplines integrated as a whole one material will have the ability to solve problems faced in real life. Furthermore, problems in real life are not separate disciplines as taught in lessons (Czerniak et al., 1999; Wang et al., 2011). For that reason, real-life problems are very complex, and it is impossible for discipline-based teaching to be able to solve and define these problems (Antov & Pancheva, 2016). So the effectiveness of STEM integration will be shown once the STEM material is organized in a PBL setting and used in one Blog by the teacher for solving a specific problem or managing a specific project in a well-defined time frame. Yet there are special conditions that need to be considered, like a method of selecting assignments for blogs, content materials selected or the method of assessing students, and the possibility of including Gamification elements within the project setting. These and other conditions may also play a role in motivating students to learn through the use of a class blog. The study aims to explore the use of a class blog in a k-12 high school classroom setting. It also aims to investigate the design and usability issues of the designed Blog under the previous conditions. Therefore, the study will try to answer the following question: Could the class blog enhance learning when used with PBL in teaching STEM material? And under what conditions would a blog achieve its goals considering k-12 students? This study is significant since it investigates the conditions and the interactions of high school students using specific web 2.0 technology settings while working as groups in project-based learning inside and outside the classroom, then it studies its relationship with their motivation to learn.

II. THEORETICAL BACKGROUND

Schools focus on ensuring that all students succeed in their lives and participate effectively in society. Technology can be used to motivate students (Madrazo, 2011; Barley, 2002). Research also reveals that using project-based learning increase the feelings of autonomy, extrinsic and intrinsic goal orientation, and task value which is related to

increased motivation among students (Madrazo, 2011). Project-based learning PBL has shown promise to be used in scientific and technology disciplines in order to deepen pedagogy instil important skills in students like collaboration and critical thinking. Yet, Information and Communications Technologies (ICT) have also been widely considered to participate in significant educational and pedagogical outcomes and support students' development. ICT can equip students with the knowledge and skills needed to succeed in 21st-century society. Graduates of secondary school need to have what is called digital literacy requirements, which includes ICT skills, Critical thinking skills, and ethical skills.

Likewise, Web 2.0 applications include blogs, wikis, social networking, social bookmarking, RSS, media sharing, podcasting, etc. These applications have enabled students to master many parts of the digital literacy requirements. Researchers, educators, academics, and policymakers have advocated the educational advantages of these emerging Web 2.0 applications. They pointed out that these applications have the potential to offer enhanced learning opportunities for both students and educators with the support to lifelong competence development (Jimoyiannis & Angelaina, 2012). The Blog is based on Web 2.0 Technology. It can be a class blog made and supervised by the teacher, or it can be a student blog for each of the students in order to document their assignments and to enable them to self-reflect. Indeed, using blogs in the classroom in either way can help increase student learning using students' preferred learning style, personal interest, and engagement. The fast online publication of a blog and a whole world audience enables the teacher to tailor the instructional materials and the assignments according to an exact level of students and enable them to work from home or from school or anywhere students are. Hence, teacher blogging bridges the gap between home and the classroom and creates an unlimited learning environment. It allows collaboration between students on many different levels, which promotes a constructive environment. So the proposed framework will combine two possible advantages; first, it may promote motivation by using PBL within ICT and blogs specifically, which is a Web 2.0 technology, and secondly, it may enhance digital literacy requirements for the secondary students through practising ICT skills and Critical thinking and other 21st century skills, which both promote lifelong learning.

A. Research Limitation

The research is conducted throughout the academic year of 2018/2019 for two 9th grade classes in a high school, all-male, school in East Jerusalem. The class blog, in this case, is a teacher showcase blog.

III. LITERATURE REVIEW

A. Students' Motivation

Motivation can be defined as the internal state that arouses, directs, and sustains students' behaviour toward achieving certain goals" (Glynn et al., 2007, p. 1089). It refers to "a student's willingness, his/her need, desire and compulsion to participate in learning, and to be successful in learning" (Feng & Tuan, 2005) which is considered to be the most important factor in self-directed learning (Glynn et al., 2011). Yet there are two main types of motivation, extrinsic and intrinsic (Legault, 2016; Madrazo, 2010). Intrinsic motivation refers to the performance of an action based on interest or enjoyment, whereas extrinsic motivation is based on an externally or socially created reason in order to perform an action. So extrinsic motivators such as money can produce extrinsic motivation because it generates a desire for the significance of the activity, though it doesn't produce a desire to engage in the activity for itself. Hence, intrinsic motivation is more important for students than extrinsic motivation. Hence, increasing students' intrinsic motivation will yield an increase in academic achievement (Albrecht, 2009). Albrecht described a program for the targeted population consisting of secondary students in the middle to upper-middle class. The students appeared to be disengaged from learning due to a lack of motivation. This lack had a tendency to lead to negative classroom behaviour and weakness of academic progress. A review of the status of these students indicated significant low motivation among secondary level students as well as coexisting behaviours. Further information was gathered in the project supporting the existence of this problem, including academic records as well as circumstantial records of student behaviour. The problem, as defined by qualified sources and educational literature, led to developing the following interventions: student autonomy, goal-setting, and positive teacher feedback. So by offering a greater number of choices to the students, providing more authentic assessments, and by allowing students to take a more active role in their own education, the Intrinsic Motivation of secondary school students will improve along with a mentality of learning for mastery as opposed to extrinsic rewards that may or may not provide enough support for the learnings. This result is also supported by Lengyel (2010), where the study that was made found that direct reading instruction and student choice had both motivated students to do better in test results as well as had a direct influence on their reading comprehension. So researchers consider that learning motivation has elements like intrinsic motivation, which refers to the satisfaction with the study itself, while self-determination represents the belief of a student in his or her ability to control his or her own study. On the other hand, self-efficacy represents the confidence to excel in the discipline learned. Grade motivation represents the desire to achieve a high score in the subject (Lee, 2017). The pedagogical content presented must be accurate, timely, stimulating, and pertinent to the student's current and future needs. The method or process used by the teacher to deliver such content must be inventive,

encouraging, interesting, beneficial, and provide tools that are pertinent to student's real life. In this case, the learning environment will be accessible, safe, positive, personalized as much as possible, and empowering. The teacher will make motivation optimized as students are exposed to a large number of these motivating experiences and variables repeated on a regular basis.

B. Motivation through ICT

A study was made on Malaysian students to train them in using computers and the Internet for search activities but were structured in a way to incorporate individual accountability, positive interdependence and interaction. The study found that motivation was improved, as well as self-confidence, learning attitudes, and achievement(Gan, 1999). Yet according to Madrazo (2010), Student motivation was at its highest level when the technology was used in creative ways, which included video editing, IPod self-pacing, and/or web 2.0 project collaboration. Hence, teachers must shift their deep-rooted instructions for worksheets, lectures, and assessment to include alternative approaches to learning through meaningful creation that includes social media and a project-driven curriculum. In this case, Motivation, Self-Confidence, Learning Attitudes, and Achievement were improved.

C. The use of PBL informal education

Formal education is the education that happens in schools in classrooms and is given usually by trained teachers. So how PBL may participate in such a setting? Well, it's one of the learning models which is appropriate for learning with a certain product as an output, like building electronic projects or creating learning media (Ummah et al., 2019). This model is appropriate for all students ranging from elementary school level to university level (Jacques, 2017; Burlbaw, 2013). PBL can also facilitate students to collaborate in conceptual understanding in order to apply prior knowledge and in order to gain skills (Roberts, 2011). PBL can also integrate several disciplines for the sake of creating one project (Capraro & Slough, 2013). Additionally, PBL enables students to demonstrate higher ability (Crowley, 2015), and it improves student achievement (Ali et al., 2011). It can even elevate students motivation to learn (Liu, 2010). Hence, it improves content knowledge, and it can be used to meet the needs of different students with a variety of skills and learning styles (Coyne et al., 2016).

D. The relation between Blogs and Motivation:

Blogs are used as supplementary mediums to promote achievement and knowledge acquisition of students as well as information searching and sharing skills within a learning community (Tekinarslan, 2010). The results are also supported by the research conducted by Hume (2012), who showed the role of online blogging in advancing student learning. The research examined students over a period of four years and examined their responses to the use of blogs and discussion boards as the main part of learning and reflection. The paper looked at how the blogging process moved students from a single-loop learning process to double-loop learning and reflection and enhanced the learning and reflection for the teacher. It demonstrated an increase in student satisfaction as measured by student evaluations and another increase in self-reflection on content-specific knowledge. The process also improved individual learning and overall classroom learning. Another advantage for blogging is that it brings about a new style of instruction called differentiated instruction for diverse students, which was the focus of a research made by Colombo & Colombo (2007), who discussed how the instructional impact of science teachers could be extended by using blogs which allowed teachers to differentiate their instruction for students with diverse needs and abilities. It's so easy for a teacher to establish a class blog that may contain text, audio, and video postings on a particular subject. Hence, digital composing in blogs promoted iterative writing and gave opportunities for multi-model expression, scaffolding and feedback. But, to benefit from this approach, not all students need to engage in such advanced, participatory and reflective composing, revising and editing activities (Hashemi, 2016).

IV. DESIGN & METHODOLOGY

This study investigates the effect of teacher blogging using various training exercises and using PBL STEM discipline (Electronics) on their motivation to learn and achieve high scores. It explores the motivation of these students working on electronics projects selected from the teacher blog postings and how they interacted with the Blog throughout their projects. The students are 9th graders from two classes, class A (n=28) and class B (n=28), all males in a technology school in Arab East Jerusalem where the academic curriculum used is the Israeli curriculum. A class blog (http://abdmth9.blogspot.com) was set up starting from September 1st, 2018 (the beginning of the first semester) in order for the students to start learning and working on electronics assignments throughout the whole academic year. Another blog was made to include specific electronics exercises related to the theme of students projects. The theme is about smart home systems where electronic sensors can be used for building their projects (http://sts2019.blogspot.com). Each Students class had two sessions for electronics and two sessions for programming (45 minutes each) per week. For electronics, one session is theoretical and conducted inside a normal class. Another practical session is in the electronics lab with 15 Pcs Pentium i5 and electronics kits. Two teachers were working with both classes, one for electronics and one for software programming. After two months of the academic year, the teachers were joined with six college students (in their senior years – from a local Academic Technological College) to support students work on their projects. The theme of all projects was building a smart home prototype using Arduino systems. So students had the

option to choose their own groups within their class in order to design their prototype.

Data was collected during the 2018/2019 academic year and during three academic semesters. Semester1 from September 1st-December 23rd, Semester2 from January 10th – April 3rd, and semester3 from April 23rd – June 20th.

Data sources, in this case, includes one years' worth of blog content, Classroom observation, school students' interviews, supervisors' interviews, and teachers' interviews to uncover their perceptions of working on an electronics project within a class blog during November 2018 and May 2019.

The researcher used strategies to store data moved forward for testing them, triangulating tentative findings, identifying patterns, and working systematically in order to identify significant truths. It is a Case Study because Case studies generate rich subjective data. They can bring to light variables, relationships and processes that value further investigation. A case study is a qualitative study that provides good stories, human interest and a more humanistic method of delivery compared to the quantitative method" (Burns, 1994). In this case, Punch (1998) asserted that "properly conducted case studies, especially in situations where our knowledge is shallow, fragmentary, incomplete or non-existent", have a valuable contribution to make (Punch, 1998, p.155). There was also Prolonged contact with informants, including continuous validation of data.

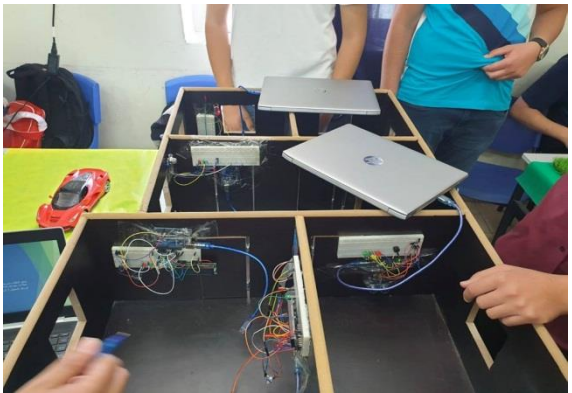
A. Limiting Bias in Interpretations

The researcher conducted a search for negative cases and checked for alternative explanations using multiple members of the research team in order to critically question the analysis. The members of the research team also had to review their results and verify them with more data sources.

The researcher developed an instrument based on unstructured and semi-structured interview questions for both teachers, supervisors and students in order to measure different variables throughout the year. The variables include motivation using PBL versus non-PBL and level of satisfaction of using blogs compared to printed materials or using a collection of internet sites. Another variable measured was the perception of the three groups of introducing gamification elements in the Blog.

V. RESULTS & DISCUSSIONS

Students started working on their projects, and they formulated nine groups, each with its own ideas to achieve. Students chose their leaders not based on who has the highest achieving scores. Instead, they were chosen based on who has the ability to lead and take action, which was more important for them. This is shown in group1, group3, group4,



group6 in this case. These projects gave silent students amazingly the ability to lead and explore their skills which are shown in the leaders of group4 and group6. Another observation was that students formed their groups based mainly on being from the same class with few exceptions, like student b17 in group1 and student b16 in group5. Some patterns of pare to 20/80 principle were observed clearly in several groups like group2, group3, group4, and group9. In fact, the leader of the group7 clearly complained that he and student b7 are the only ones working and putting efforts to manage the project. Some low achieving students like student a13 had the chance during the project to show his non-academic skills in building the frame of the smart home, which interestingly had motivated him. Many Gamification elements had a positive effect on students; the first gamification element observed was that after forming groups, students were so excited in naming their groups with names related to playing teams which gave them the motivation to continue working. The second gamification element noticed was the effect of introducing awards for the three winning groups Award1 for the highest achiever, Award2 with has less value than award1 which is appointed for the second achiever and Award3 which has less and less value for the third-highest achiever. It was clearly announced that other groups would have no award, so there is a sense of loss if they did not make their project win. The supervisors had anticipated the success of the PBL through their continuous support to students and throughout the project period. Creativity and Innovation patterns were shown by students when they had the option to build their smart home frame the way they liked; some used wood, others used strong carton boxes, and they were excited in colouring their homes, and many were willing to stay late after school to work on their smart homes more to win the prize than getting the best highest grade. Throughout the project period, students and supervisors were reverting to both blogs as references to help them solve any problem they were facing, like group 9, which had a problem configuring the use of knock-knock patterns to make the door open, so they needed analytical skills to configure such knock-knock patterns. Also was observed the problem-solving skills that students acquired throughout the project period. Collaboration varies from group to group, where it was noticed clearly in group1,

group5, and group8 but was less in other groups and much less in groups like group7, and group4. Students demonstrated their communication skills when trying to convey their opinion about some parts of the project that they are working on or trying to convince their member's team about their opinion. Students also demonstrated critical

thinking skills. Students who can think critically would grow into lifelong problem solvers. Many students (but with varying range) and throughout the project had shown that they could take information about their project and analyze it, drawing conclusions about specific solutions to problems they face. They were able to form and defend opinions about why they selected this approach with data to back it up. They were able to reflect on their work and were able to approach problems they faced in a systematic way. Students had to pay for the expenses of their smart home from their own pockets and were willing to do so when they felt that the project was also part of the school academic requirement to pass the electronics class. It's obvious because the financial support is coming from parents who are willing to support financially as long it is part of the school official "education". Hence, the two blogs used were also helpful to show parents such "educational" assignments. So the two blogs used were helpful for both the teacher, the supervisors and the students. The teacher was able to structure the content materials in the class blog, help students build their technical knowledge bit by bit, modify posts if needed and publish the modification simultaneously. Supervisors were using it as a reference to help students build their projects. As supervisor2 puts it, "It's a well-organized place that can be updated immediately. It can accompany students as a reference, and as an organizer throughout their projects". But how do teachers, supervisors, and students perceive these blogs? As the researcher interviewed them throughout the academic year, as shown in Table4 where teachers were asked several times every month starting from month1 which corresponds to November when students start working on their projects, they were asked to rate using blogs as a reference, as an ideas organizer versus printed materials like books and printed worksheets, and also versus a list of internet sites for students to navigate. Teachers were asked to rate their preference from 1 to 5, where 1 has the least value, and 5 has the highest benefits value.

Table 1. Teachers perceptions ratings from (1 to 5) of Blogs use versus other sources

Month	Blogs	Printed Materials	Internet sites
Nov'18	4	2	1
Dec'18	4	2.1	1.5
Jan'19	4.1	2.2	1.3
Feb'19	4.4	2.3	1.2
Mar'19	4.3	2.4	1.6
Apr'19	4.4	2.2	1.3
May'19	4.5	2.5	1.2

As in Fig.2, the data was plotted and shows clearly that blogs have the highest rate as a preferred source for teachers versus printed materials and internet sites.

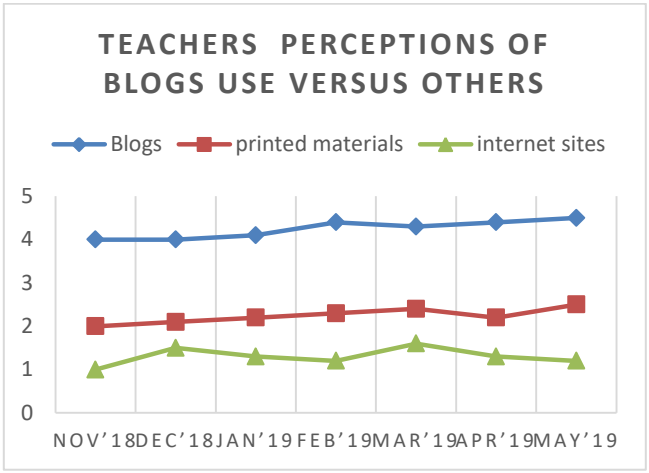


Fig. 1 Teachers perceptions of Blogs use versus others

As Teacher2 put it, "You can't include videos or high-resolution coloured photos in printed materials" he also added that "giving students multiple internet sites to navigate may confuse students". Teacher1 also added, "you may be able to print coloured electronic sketch drawings, but students will lose them easily or forget to bring them with them when they need them".

Table5 show the benefits rating of using blogs according to supervisors where they spent an hour and a half per week for a duration of seven months, and they perceived the benefits of blogs as shown.

Table 2. supervisors perceptions of Blogs use versus others

Month	Blogs	Internet Sites	Printed Materials
Nov'18	4	1.9	2.7
Dec'18	4	1.8	2.6
Jan'19	4.1	1.9	2.6
Feb'19	4.4	1.8	2.5
Mar'19	4.3	1.7	2.4
Apr'19	4.4	1.6	2.5
May'19	4.5	1.5	2.4

Very similar to how teachers perceived the benefits of blogs, but as fig.3 shows, internet sites had a closer gap with blogs which can be explained by an insufficient pedagogical understanding between blogs and internet sites, but both had higher preference than printed materials. Yet at the end of the

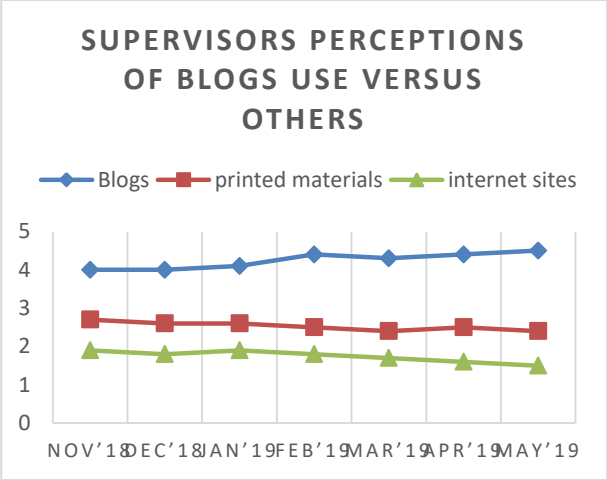


Fig. 2 Supervisors perceptions of blogs use versus others

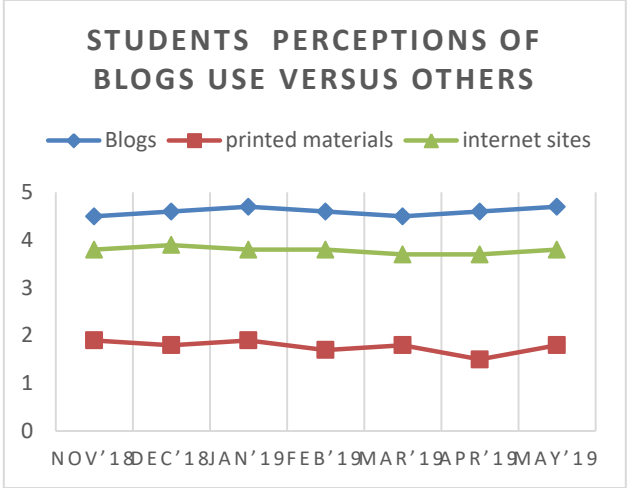


Fig. 3 Students perceptions of blogs use versus others

year, the gap between blogs and internet sites had increased after recognizing the difference between them. But for students, as shown in Table6, the difference between blogs and internet sites is not clear, so they rated using internet sites higher and close to their rating of Blogs. Again, the pedagogical difference between blogs and internet sites is also less and less clear for them, which continued until the end of the year.

Table 3. Students perceptions of Blogs use versus others

Month	Blogs	Printed Materials	Internet Sites
Nov'18	4.5	1.9	3.8
Dec'18	4.6	1.8	3.9
Jan'19	4.7	1.9	3.8
Feb'19	4.6	1.7	3.8
Mar'19	4.5	1.8	3.7
Apr'19	4.6	1.5	3.7
May'19	4.7	1.8	3.8

This explains the stable perception for students about the difference between blogs and a list of internet sites. Yet the rating given, as in Fig.4, is related to the academic achievement as low achieving students like student a13 and student b25 tend to perceive a lower gap between blogs and internet sites compared to high achieving students like student a9 and student b10

But for average achieving students, the relationship between their answers and their academic achieving is not obvious but tend to be related to other factors like technical knowledge and Critical thinking skills.

VI. CONCLUSION

Blogs are web 2.0 tools that proved to have many pedagogical advantages for students informal settings. Blogs were used in this research as class blogs which had provided support and help for students working in their STEM project using the PBL method of education. Hence, blogs have provided an organized way to retrieve information in order to build on the knowledge they have. This type of organization and support is crucial, especially when working with the STEM discipline. By using PBL with Blogs, students had also gained 21st-century skills like problem-solving, Critical thinking, Collaboration and communication, Creativity and Innovation. The combined setting enabled authentic assessment, which promotes learning, collaboration and creativity. Other variables can be introduced within these settings, which may increase student motivation and engagement if applied in a proper way which includes Gamification and contents of blog postings.

A. Directions for Future Research

As this research is using class blogs to enable PBL in STEM disciplines, it will be interesting to explore the use of students blogs within these types of projects in order to measure any motivation on engagement gain through their work or even to measure any other advantages like student reflection once they use their own blogs as e-portfolios in order to document their work in this STEM project during the academic year and their individual thoughts about the project planning and building process. Also, it's interesting to explore the use of the same research setting on all-girls groups or a mix of males and females to measure any difference, if any.

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