The Effect of the STEAM-GAAR Field Learning Model to Enhance Grit

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Abstract – **The aim of this research was: 1) to synthesize the learning system; 2) to compare the pre-test and post-test grit score; 3) to compare a formative evaluation of the grit score with the criteria; and 4) to study the correlation between grit score and learning achievement score. Results exhibited that: 1) the learning system has 9 segments. 2) the post-test grit score was higher than the pre-test score at a .01 level of significance; 3) the level of grit after using the developed model is 81.74 per cent, which is above the 80 per cent threshold; 4) grit was correlated with a learning achievement of 0.77.**

Keywords – **STEAM, Gamification, Animation, Augmented Reality, Field, Grit, Learning System.**

1. Introduction

Grit is one of the 16 important characteristics that 21st century students must have [1]. It is the key to success in life and work, and is a long-term effort; it is like a marathon not a sprint. The research indicates that if the students are very persistent they are often successful in learning and work. The grit of a learner is due to both internal and external factors. External factors include a close network of people such as family or friends. Internal factors are: purpose, interest, hope and practice [2]. Teaching in the 21st

century should develop the grit of students [3]. Using the STEAM learning process will allow the learner to learn by knowledge integration [4]. Science, technology, engineering, art and maths, applied with information and communication technology (ICT), such as gamification, animation and augmented reality (AR), can enhance internal factors of grit, which are: purpose, interest, hope and practice [5].

STEAM education is teaching by the integration of science, technology, engineering, art and maths. This promotes creativity, critical thinking and problem solving of students, suitable for 21st century learners [4].

Gamification is a method that uses the rules of games in non-gaming content; for example, reward points, a leader board and a winner's award. It encourages students to be interested in and enjoy learning [6].

Animation is a media of several still images that changes with speed. The picture is persistent. Animation can be in two or three dimensions [7], i.e. as a cartoon from Disney classics [8]. It is useful for explaining incomprehensible content, gaining more attention and memorizing content [9].

Augmented Reality (AR) is a technology processor that uses an image created by a computer program, overlapping with an image of the real world, through the camera lens, which then appear in real time on a monitor, smart phone display or tablet display [10,6]

A Virtual World is a place that simulates a person or place in a virtual environment by using a computer program. It is currently very popular and is suitable for applications in lesson learning [11]. The field in this study refers to the real world space in both the classroom and the virtual world space.

The STEAM-GAAR Field Learning Model to Enhance Grit [5] is using many technologies through the STEAM education. It stimulates four factors: Purpose, Interest, Hope and Practice to enhance the grit of the learner (Figure 1.).
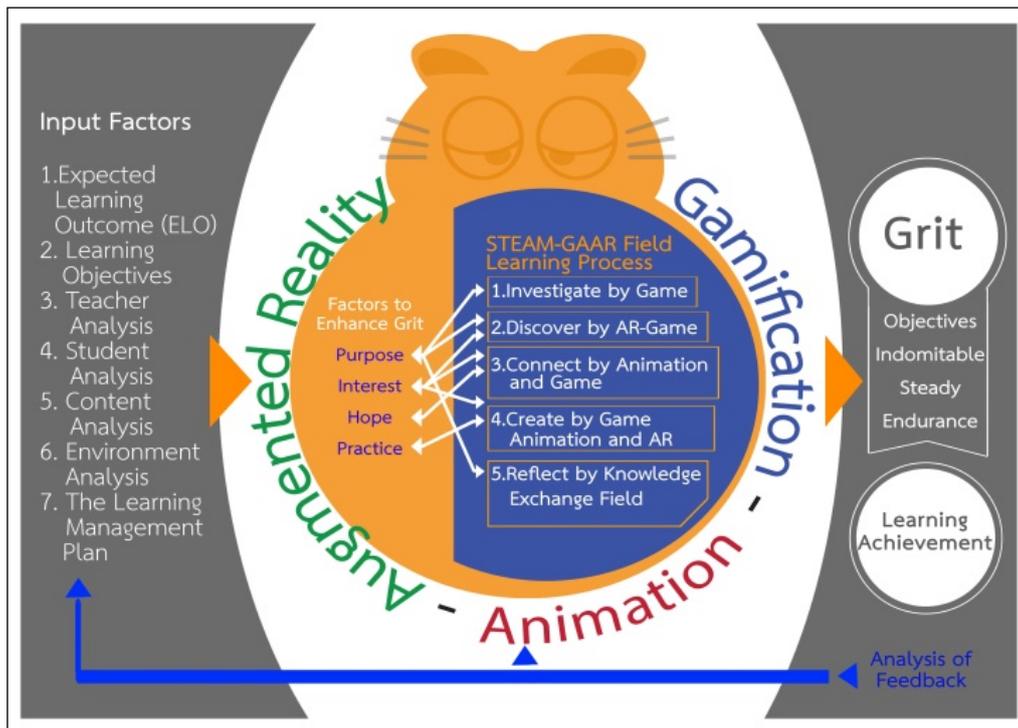
Figure 1. STEAM-GAAR Field Learning Model to Enhance Grit (Chujitarom and Piriyasurawong, 2018)

2. Objectives

2.1 Synthesize the learning system.

2.2 Comparison of the pre-test and post-test grit score.

2.3 Comparison of a formative evaluation of the grit score with the criteria.

2.4 Study the correlation between a formative evaluation of the grit score and a formative evaluation of the learning achievement score.

3. Research Scope

Population and samples:

3.1 The population consisted of 100 first year students who study in DGA 131: Digital Art Applications, during the summer semester in the 2018 academic year at the Faculty of Digital Art, Rangsit University, Thailand.

3.2 The samples consisted of 38 first year students. Random segment sampling was used.

4. Research Methodology

The research methodology was divided into five phases as follows:

The first phase: Implementing the learning model [5] with the samples. The students complete a self-assessed grit scale [2] in the classroom as a pre-test. Then, 38 students of DGA 131 were taught lessons in digital art applications according to the STEAM-GAAR Field Learning Process[5].

The process was divided into five steps as follows:

1) Investigate by Game. The instructor gave the students a problem to solve about the content of the lesson. To help students explore the issues involved, the learners have to investigate the area both inside and outside the classroom by gathering four people, then helping each other to find a solution. Points accumulate on a leader board and at the end of the semester the winner is revealed. Solutions to the problem are hinted at on the poster (Figure 2.).

Figure 2. Investigate by Game Process

2) Discover by AR-Game. The instructor created a poster with the content of augmented reality to attract the students' attention. When the students find answers to the poster, they propose solutions which can be used both in the classroom and in the virtual world (Figure 3.).
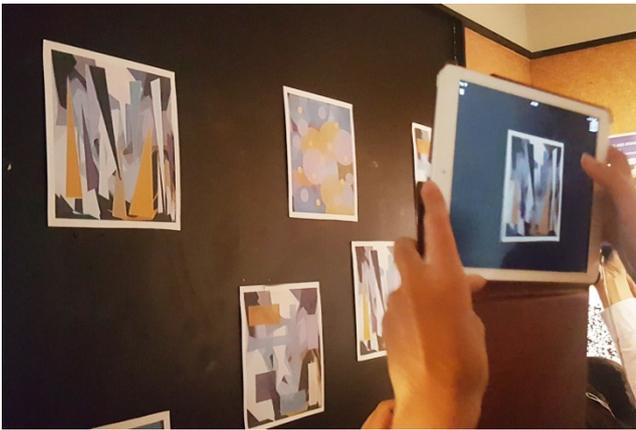
Figure 3. Discover by AR-Game Process

3) Connect by Animation and Game. When learners gain knowledge through investigation and discovery, they bring knowledge together and gain new knowledge. The instructor arranges the animation content of the lesson to inspire them. Those who can answer the problem by watching the animation will get points to go on the leader board (Figure 4.).

Figure 4. Connect by Animation and Game Process

4) Create by Game Animation and AR. Students are challenged to create works using animation and AR. They also apply scientific discovery and use technologies such as the internet, engineering, art and mathematical calculations. The most complete piece of work is awarded points for the leader board (Figure 5.).
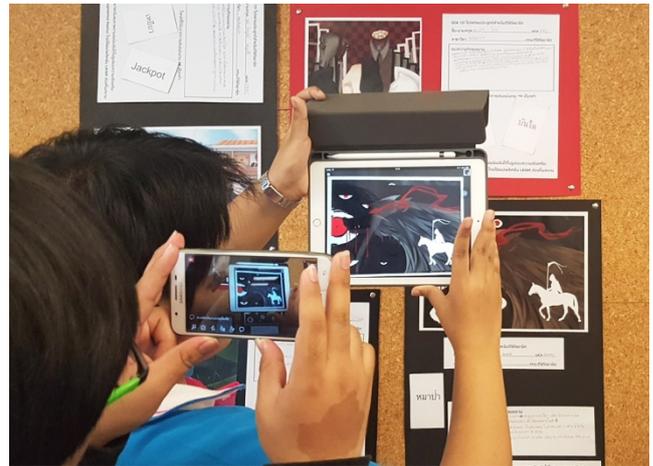

Figure 5. Create by Game Animation and AR Process

5) Reflect by Knowledge Exchange Field. Students reflect on learning outcomes by exchanging ideas and receiving advice from teachers and classmates. This occurs both in the classroom and in the virtual world to develop improvements (Figure 6.).
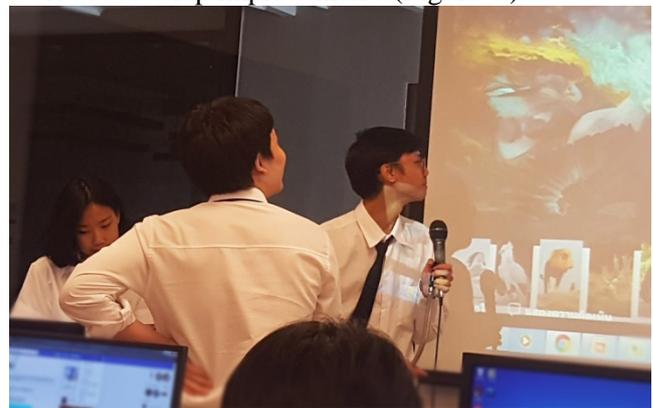

Figure 6. Reflect by Knowledge Exchange Field Process

During the semester, the instructor assigns five projects and observes the students by using scoring rubrics to evaluate the grit and learning achievements of the learners. At the end of the semester, students complete the self-assessment grit scale once again as a post-test.

The second phase: Analyze the learning system from the learning schedule and learning activity.

The third phase: Compare the pre-test and post-test grit score. Self-evaluation was used. The statistics used were t-test for dependent means, with a hypothesis of a .01 level of significance. Self-evaluation was done on a Likert scale.

The fourth phase: Compare the formative evaluation of the grit score with the criteria. The hypothesis criteria had an average of 80 per cent average. Individual scoring rubrics were used through five assigned projects.

The fifth phase: Study the correlation between a formative evaluation of the grit score and a formative evaluation of the learning achievement score. Two, separate scoring rubrics were used. The first is a scoring rubric for grit observation. The second rubric is to observe outcomes of learning achievement; both were carried out by the instructor. A Pearson correlation coefficient (PCC) was used.

5. Results

5.1 Learning System

The learning system is divided to 9 segments as follows:

Segment 1: Learning Management Plan, it is the preparation of each instruction that learners must learn and perform. In this research, the instructional plan is divided into 15 sessions, including pre-test and post-test, which took about 3 months.

Segment 2: Game for Learning, is preparing the game or creating a game with a lesson content. And give points to those who participate in the game. Researchers have prepared a leaderboard. Those who can answer the questions in the lesson will earn points. The students with the highest points will win and be rewarded.

Segment 3: Animation for Learning, instructors provides animation with lesson material or creates animations with lesson material, which inspire the grit for the students. In this research, researchers have created short animation "3,500 times of grit" for students to watch. The content of nesting birds that has a hard time to build a nest. To give students hope and inspiration.

Segment 4: AR for Learning, the instructor prepares AR for lessons such as AR knowledge book, AR knowledge game card or AR knowledge poster for students to use.

Segment 5: Real World for Learning, students can discuss and exchange ideas directly in the classroom.

Segment 6: Virtual World for Learning, students can talk and exchange ideas, through the virtual world provided by the instructor.

Segment 7: Grit Rating Scale, students make self-assessment before and after class.

Segment 8: Grit Rubrics Evaluation, there are 4 topics: goal, endurance, effort, indomitable. Using one-to-one observations by teacher and assessing the rubrics point in each lesson.

Segment 9: Learning Achievement Rubrics Evaluation, there are 4 topics: achievement, beauty, aptitude and creativity. Using one-to-one observations by teacher and assessing the rubrics point in each project. The learning system is separated to 9 segments because it is not necessary to run it step by step, the learning system can swap or start from any segment. See in figure 7.
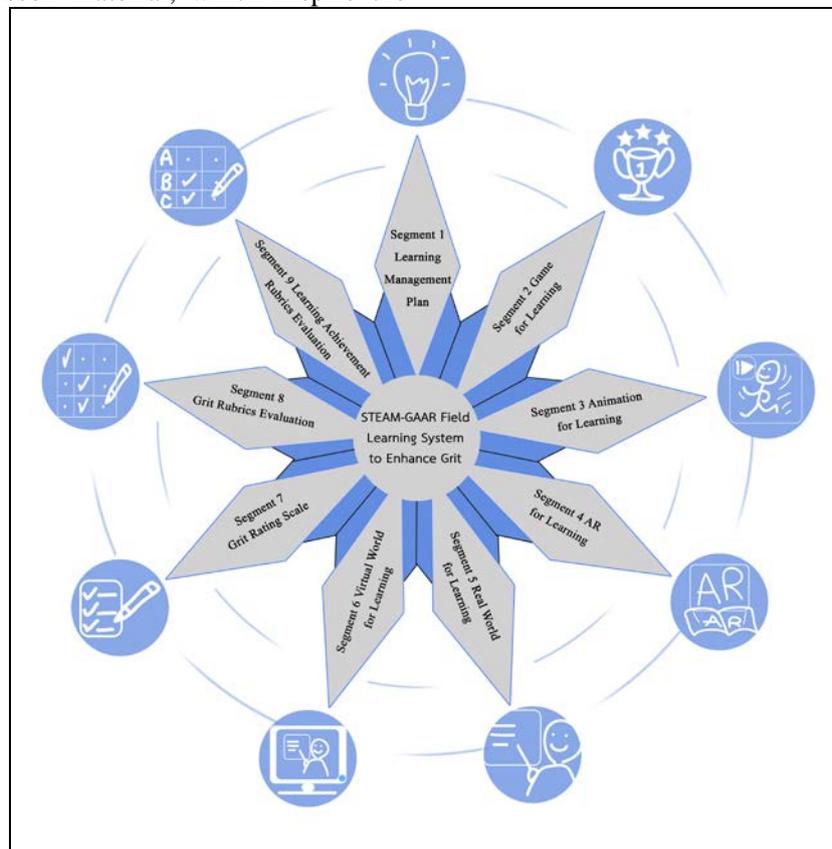

Figure 7. The Learning System

5.2 The post-test of grit after using the model was higher than the pre-test at a .01 level of significance.

The sample group of 38 students used a Likert scale to undertake a self-evaluation on their level of grit. Full marks on the scale was a score of 5. Pre-test evaluation ($\bar{x}$) was at 3.23 and Standard Deviation (S.D.) was at 0.39. Post-test evaluation ($\bar{x}$) was at 3.40 and Standard Deviation (S.D.) was at 0.41. One-tail hypothesis testing from pre-test and post-test at 0.0014 refers to a .01 level of significance (Table 1.).

Table 1. Summary of pre-test and post-test

38 Students	Full Marks	Evaluation ($\bar{x}$)	Standard Deviation (S.D.)	significance
Pre-Test	5	3.23	0.39	
Post-Test	5	3.40	0.41	0.0014

5.3 The grit level after using the model developed above the 80 percent threshold

A formative evaluation of the grit score was carried out by observing scoring rubrics. Five projects were assigned during the semester. The instructor carried out individual observations.
Total marks for each individual project is 10 points; the total mark for the five projects is 50 points. A final percentage was then calculated.
The result of a formative evaluation of the grit score was as follows:

Project 1: average at 8.18 point (81.8 %) which means it is very good;
Project 2: average at 7.76 point (77.6 %) which means it is good;
Project 3: average at 8.08 point (80.8 %) which means it is very good;
Project 4: average at 7.92 point (79.2 %) which means it is good;
Project 5: average at 8.92 point (89.2 %) which means it is very good.
The average of the five projects is 40.87 points (81.74 %) which means it is very good, and is above the 80 per cent threshold (Table 2.).

Table 2. The grit level after using the model with the criteria.

38 Students	Average	Percentage	Criteria
Project 1	8.18	81.8	Very Good
Project 2	7.76	77.6	Good
Project 3	8.08	80.8	Very Good
Project 4	7.92	79.2	Good
Project 5	8.92	89.2	Very Good
Sum	40.87	81.74	Very Good

5.4 Grit was correlated with learning achievement

The correlation between grit score and learning achievement score using a formative evaluation by the teacher's rubric observation. The teacher carries out individual observation and the rubric score is divided into two parts. The first part is the grit rubric score; the second part is the learning achievement rubric score. The total mark for each project is 10 points. The total possible score of the five projects for both grit score and learning achievement score is 50 points.

The statistics used a Pearson correlation coefficient (PCC) to measure between the two variables: learning achievement and grit. A value between +1 and −1, where 1 is total positive correlation, 0 is no linear correlation, and −1 is total negative correlation.

A summary of the correlation between grit score and learning achievement score using the model is as follows:
Project 1: Grit was evaluated ($\bar{x}$) at 8.18 and Standard Deviation (S.D.) at 1.11. Learning achievement was evaluated ($\bar{x}$) at 7.95 and Standard Deviation (S.D.) at 1.09. Both have a correlation at 0.83.
Project 2: Grit was evaluated ($\bar{x}$) at 7.76 and Standard Deviation (S.D.) at 0.91. Learning achievement was evaluated ($\bar{x}$) at 7.34 and Standard Deviation (S.D.) at 1.05. Both have a correlation at 0.79.
Project 3: Grit was evaluated ($\bar{x}$) at 8.08 and Standard Deviation (S.D.) at 0.97. Learning achievement was evaluated ($\bar{x}$) at 7.74 and Standard Deviation (S.D.) at 1.18. Both have a correlation at 0.70.

Project 4: Grit was evaluated ($\bar{x}$) at 7.92 and Standard Deviation (S.D.) at 0.67. Learning achievement was evaluated ($\bar{x}$) at 7.71 and Standard Deviation (S.D.) at 0.84. Both have a correlation at 0.78.

Project 5: Grit was evaluated ($\bar{x}$) at 8.92 and Standard Deviation (S.D.) at 0.82. Learning achievement was evaluated ($\bar{x}$) at 8.55 and Standard Deviation (S.D.) at 1.03. Both have a correlation at 0.76.

Thus, the average correlation value of the five projects is 0.77, which is nearly a total positive linear correlation (+1) (Table 3.).

Table 3.Summary of the correlation between grit score and learning achievement score

Project Assignments	Learning Outcome	Evaluation ($\bar{x}$)	Standard Deviation (S.D.)	Correlation
Project 1	Grit	*8.18*	*1.11*	*0.83*
	Learning Achievement	*7.95*	*1.09*	
Project 2	Grit	7.76	0.91	0.79
	Learning Achievement	7.34	1.05	
Project 3	Grit	8.08	0.97	0.70
	Learning Achievement	7.74	1.18	
Project 4	Grit	7.92	0.67	0.78
	Learning Achievement	7.71	0.84	
Project 5	Grit	8.92	0.82	0.76
	Learning Achievement	8.55	1.03	
Average Correlation				0.77

After using the model there was an average correlation value of 0.77 between grit score and learning achievement score. The result can be explained in the scatter diagram below; the two variables are learning achievement (X) and grit (Y). The scatter diagram shows that students who get a high score of grit also get a high score of learning

achievement; i.e. a student who gets a score of 10 for grit, also gets a score of 9 or 10 for learning achievement. On the other hand, students who get a low score of grit also get a low score of learning achievement; i.e. a student who gets a score of 6 for grit, also gets a score of 6 or 7 for learning achievement (Figures 8-12).
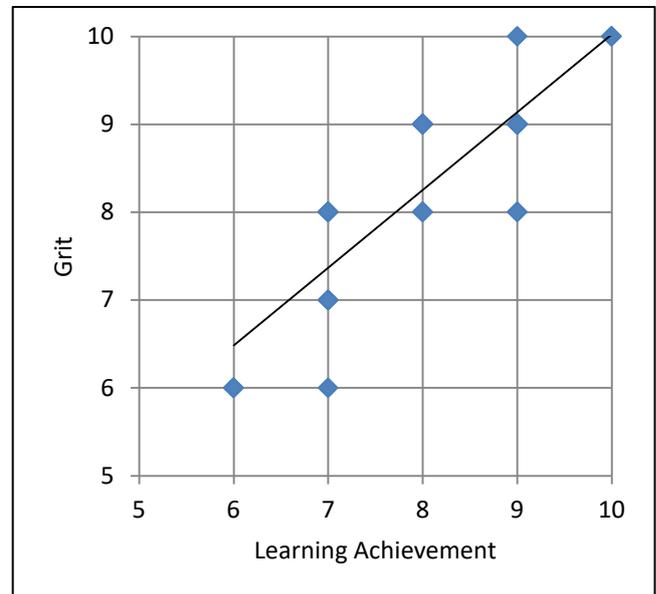

Figure 8. Project 1: Scatter Diagram of Grit and Learning Achievement Correlation
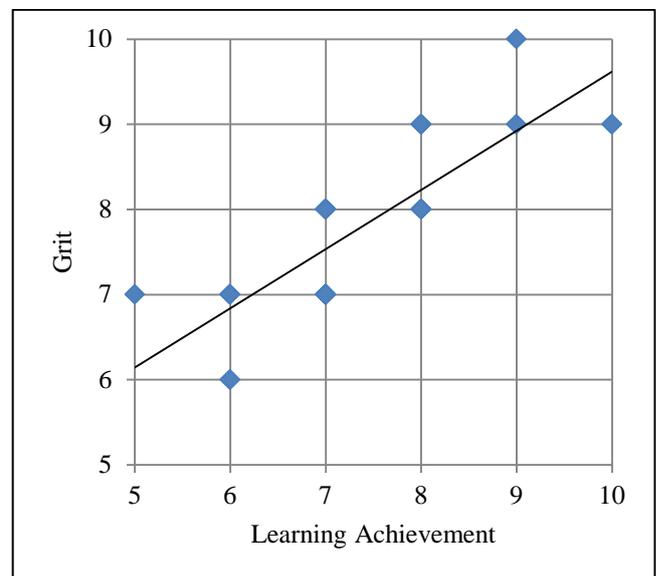

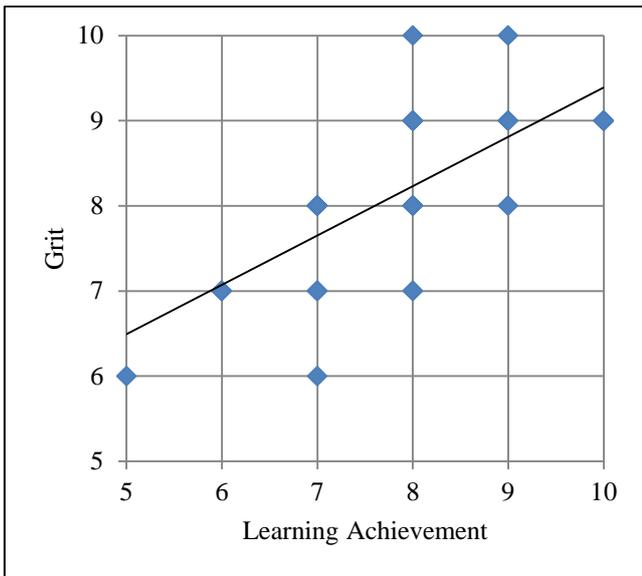*Figure 9. Project 2: Scatter Diagram of Grit and Learning Achievement Correlation*

Figure 10. Project 3: Scatter Diagram
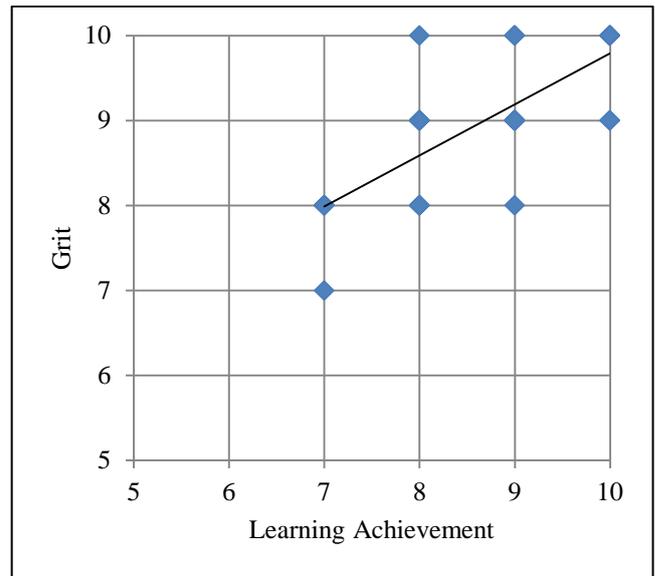*of Grit and Learning Achievement Correlation*

Figure 12. Project 5: Scatter Diagram
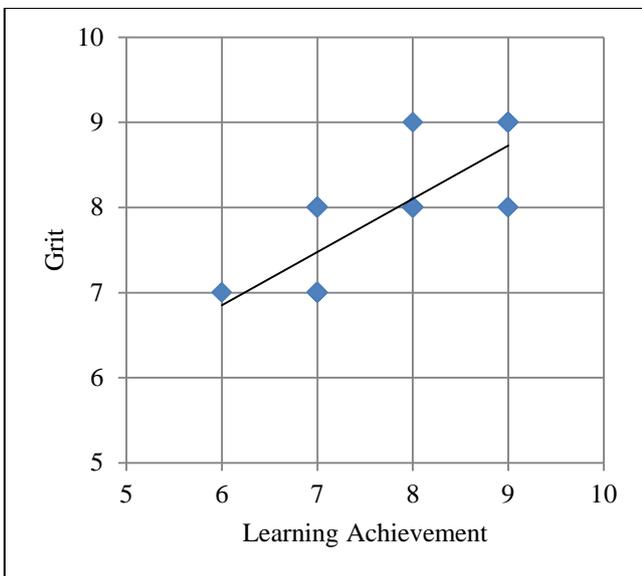*of Grit and Learning Achievement Correlation*

Figure 11. Project 4: Scatter Diagram
of Grit and Learning Achievement Correlation

The total possible score for projects 1 to 5 is 50 points. The average correlation value of the five projects is 0.77. Students who get a learning achievement score of 35 points or above also get a grit score of 36 points or above. The results can be explained in the scatter diagram below (Figure 13.).
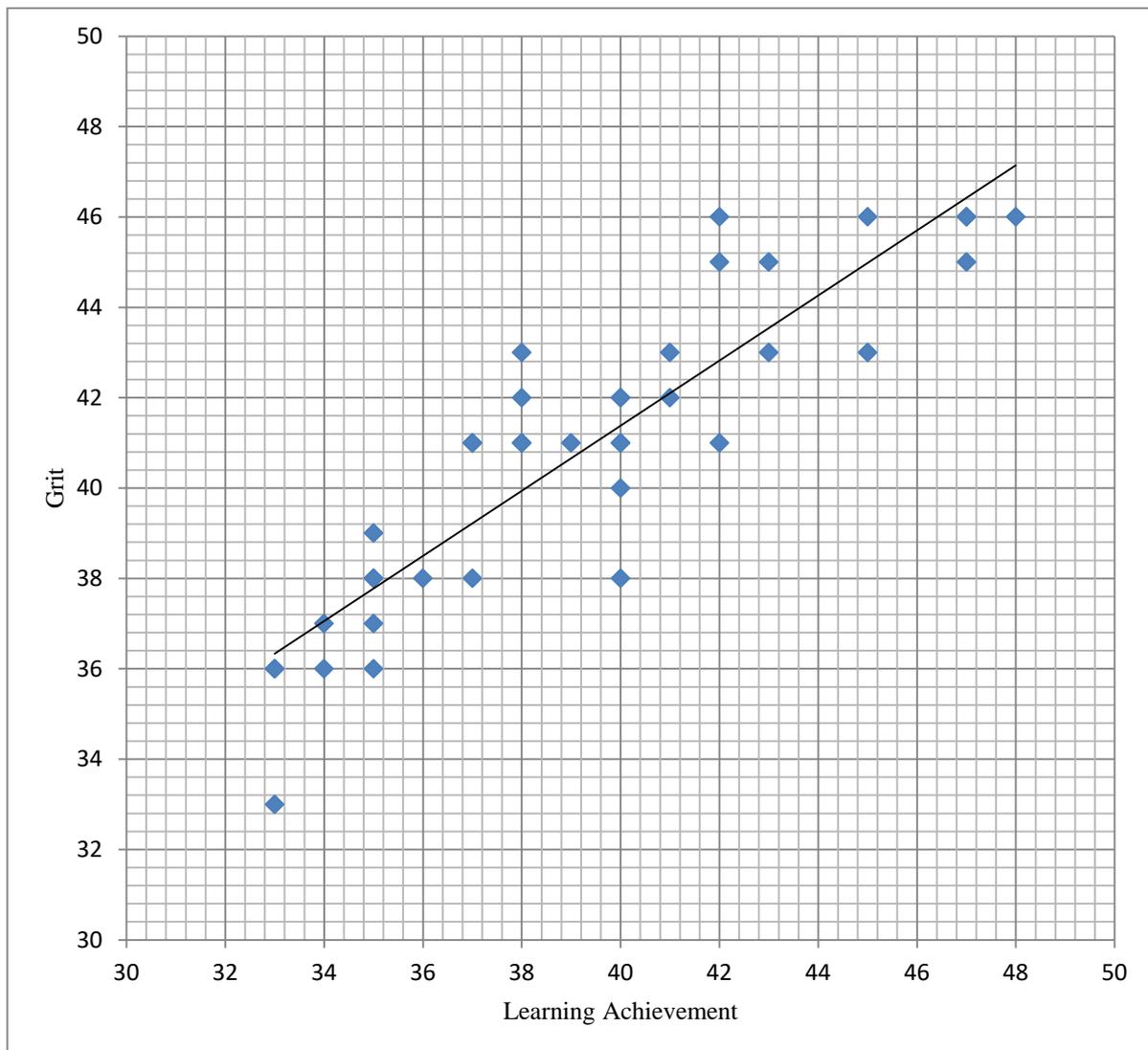
Figure 13. Scatter Diagram of Grit and Learning Achievement Average Correlation

6. Discussion

The results show that implementing the model which uses information and communication technologies, can boost the factors of grit, i.e. purpose, interest, hope and practice. These results agree with Yamabe, Asuma, Kiyono and Nakajima (2011) [12]. They stated that gamification, animation and augmented reality can improve achievement, motivation, interest in learning and practice. After using the model, the post-test score of grit was higher than the pre-test score, with a .01 level of significance, as suggested by Chujitarom and Piriyasurawong (2017) [5]. They found that ten specialists evaluated and agreed that the model is suitable to enhance grit. The results also show that, grit was correlated with learning achievement at a .01 level of significance. The results can also be related to Duckworth et al. (2007) [13] who found that students who have high GPAs also earned high scores in grit. They suggested that the true

correlation between grit and achievement maybe higher than their observations. They plan to develop information report, content analysis, and bio data measures of grit in future research.

7. Conclusion

The effect of implementing the learning model shows that:

1) The STEAM-GAAR Field Learning System divided to 9 segments: Segment 1- Learning Management Plan, Segment 2 - Game for Learning, Segment 3 - Animation for Learning, Segment 4 - AR for Learning, Segment 5 - Real World for Learning, Segment 6 - Virtual World for Learning, Segment 7 - Grit Rating Scale, Segment 8 - Grit Rubrics Evaluation, and Segment 9 - Learning Achievement Rubrics Evaluation.

2) After using the model, the post-test score of grit was higher than pre-test, at a .01 level of significance.

3) After using the model, the level of grit was above the 80 per cent threshold.

4) After using a model, grit was correlated with learning achievement at 0.77, which is nearly a total positive linear correlation (+1).

The research also demonstrated that internal factors of grit (purpose, interest, hope and practice), can be encouraged by using information and communication technologies such as gamification, animation, augmented reality and virtual world, and these can be applied via a STEAM education.

Acknowledgements

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