Curiosity killed the cat, but satisfaction brought it back; the benefits of curiosity and intrinsic motivation on learning and education

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Abstract

Curiosity is a debatable subject as researchers of the last century have not agreed on taxonomy, arguing from everything between drive theories to cognitive theories. Though the arousal of curiosity is not properly understood yet, measurable frameworks have been developed and this article will browse into Self Determination Theory, drive theories, and cognitive theories in an attempt to understand curiosity and intrinsic motivation's effect on learning, or perceived competence. Research from the last decade indicate significant correlations between curiosity and intrinsic motivation, curiosity and learning, and intrinsic motivation and learning, yet causality is still a vital problem in fully understanding curiosity.

This study examined the variables of curiosity, intrinsic motivation, self-regulation and learning, as well as their underlying facets; and found several significant correlations indicating a relationship between curiosity, intrinsic motivation, and learning. Upon testing for causality between groups, no results were found due to a violation of sphericity. The paper continues to assess the limitations of the study, mainly a minimal sample size, and the possible validity of trait curiosity theories. Concluding, more research is needed to judge whether curiosity can be considered a trait or state.

Table of Contents

Introduction 9
Purpose of Study 9
Fields of Interest 9
Hypothesis 10
Theory 11
Curiosity 11
Early theories. 11
Definition. 11
Evolution. 12
Similar Topics 13
Motivation 13
Intrinsic motivation 13
Evolution 14
Extrinsic motivation 14
Intrinsic motivated curiosity. 14
Self-Determination Theory 15
Amotivation. 16
Self-Regulation 16
Learning 17
Evolution. 18
Method 18
Theory 18
Scales 18
Curiosity and exploration inventory (CEI-I). 18
CEI-II. 19
Perceived competence for learning scale. 19

Learning self-regulation questionnaire. 19
Learning outcome. 20
Intrinsic motivation inventory. 20
Removed scales 20
Measurement Selection 21
Design 21
Design limitations. 22
Selection 22
Age 23
6-point Scale 23
The Experimental Procedure 23
Intervention group. 23
Control group. 23
Analysis 24
Survey. 24
SPSS. 24
Data Collection 24
Information gathering. 24
Errors 24
Idling. 24
Results 25
Descriptive Statistics 25
Gender Scores 28
Correlations 28
Correlations Split File 29
Pre-test. 29

Post-test control group. 30
Post-test experiment group. 31
Spearman's rho. 33
Test of Normality 34
Regression 34
On perceived competence for learning. 34
On learning outcome. 35
Compare Means 36
Curiosity. 36
Intrinsic motivation. 36
Self-regulation. 36
Perceived Competence for Learning. 36
ANOVA 36
Repeated Measures ANOVA 37
Mauchly's test of sphericity. 37
Bonferroni method. 37
Post hoc. 38
MANOVA 38
Discussion 38
Intrinsic Motivation & Curiosity 39
Intrinsic motivation results. 39
Intrinsic or Extrinsic? 40
Intrinsic motivation and learning results. 41
Difficulties of Implicating Intrinsic Motivation to Education 41
Interest 42
And curiosity. 42

And motivation. 42
And self-regulation. 43
Types of interest 43
Flow 44
Cognitive Evaluation Theory 44
Perceived Competence and Exploration 45
Perceived competence findings. 45
Self-Regulation 46
Autonomous and controlled regulation. 46
Autonomous regulation results 47
Self-Regulation in Education 47
Epistemic Curiosity 48
Information Gap & Loewenstein 49
Applying Curiosity in Education 50
Detriments of Curiosity 50
Curiosity and Learning 51
Curiosity in school children. 51
Intrinsic Motivation in School 52
Teachers' role. 52
Teaching Strategies 53
Learning 55
Deep and surface learning. 55
Learning in education. 56
Reporting effects on learning. 56
Value 57
Neuroscience 59

SEEKING System. 60
Neurological support for intrinsic motivation. 61
Trait Theories 62
Curiosity Trait Theory 63
Interpersonal Curiosity 63
Social Curiosity 64
Cooperation and Social Play 64
The ambiguity of play. 65
Types of Curious People 65
Five Dimensions of Curiosity 67
Well-being of Curiosity 68
Findings Between Groups 68
Intelligence and Curiosity 69
Intellect in curiosity scales 69
Curiosity Beyond Education 70
Computer enhanced learning. 71
Curiosity in the workplace. 71
Limitations and Future Studies 72
Conclusion 73
References 75
Survey 90
Graphs 93
Correlations Table 1 93
Correlations Table 2 95
ANOVA Table 1 98
Independent Samples T-Test 1 (between pre-test and experiment group) 99

Independent Samples T-Test 2 (between pre-test and control group)..... 100

Test of Sphericity 1 101

Introduction

Purpose of Study

Curiosity is a debatable subject as researchers of the last century have not agreed on a definition, arguing from everything between drive theories to cognitive theories. Though the arousal of curiosity isn't properly understood yet, measurable frameworks have been developed and this article will browse into Self-Determination Theory (SDT), drive theories, and cognitive theories in an attempt to understand curiosity's effect on intrinsic motivation, and how curiosity individually and combined with intrinsic motivation affect learning or competence.

As this debate have been going on for the past 70 years, this paper will accept curiosity as a broad term and have no intent of attempting to resolve its debated definition or causality, instead focusing on the effect of curiosity, as a broad term, on (or as) intrinsic motivation, and learning. A common theme among both curiosity and intrinsic motivation, which the paper will delve into later, is the exploratory behavior found in most animals, which unhindered by ambivalent theories and taxonomy will be heavily explored in this paper.

The purpose of this study is to address whether curiosity and intrinsic motivation may be influenced through self-regulation and freedom of choice to achieve a different learning outcome than a regular class. To my knowledge, there has been no attempt to experimentally affect curiosity in a pretest-posttest design. However, many studies indicate a strong correlation between curiosity and learning, through self-report questionnaires (Sinha, Bai, & Cassell, 2017; Vallerand et al., 1992; Rossing & Long, 1981; Renner, 2006).

Learning will be addressed from two perspectives; (1) learning outcome, a simple measure of the students' perceived learning outcome or expected learning outcome, and (2) perceived competence for learning, a SDT variation of learning where the questionnaire measures the students' confidence that they are capable to learn or master the material.

Curiosity is often a concept appointed to children, this paper will discuss the relevancy and use of the term among children. But as curiosity affect individuals of all ages, it would be of interest to see if utilizing curiosity can have a beneficial effect on students at a more advanced level.

Fields of Interest

In regards of the scientific significance of this study, the research conducted is hoped to further map the ever-evolving field of education by contributing results of curiosity's

correlation to learning among older students. Due to the nature of curiosity, this study will heavily assess the use of curiosity as a means of learning.

While this study does not experimentally test any neurological connections, some neuroscientific studies have linked curiosity and intrinsic motivation to learning (Panksepp, 2004; Panksepp, 1998; Panksepp & Biven, 2012; cited by Domenico & Ryan, 2017). Furthermore, Edelman's theory of neural Darwinism (1993) embraces the neuroscience behind learning mechanisms.

Finally, though it may seem more abstract, recent studies (Wu & Miao, 2013; Agina, 2012) have utilized curiosity and intrinsic motivation in programming to enhance learning, as well as in robotics and artificial intelligence.

Curiosity affects many aspects of our lives, this study will undoubtedly not be able to cover them all, the same can be said in regards of what fields of interest this study may touch upon.

Hypothesis

This study operates under several minor hypotheses, but the first four is of particular interest, as well as the last four:

H1: Higher levels of curiosity positively affects learning outcome.

H2: Curiosity positively affects perceived competence for learning.

H3: Intrinsic motivation positively affects learning outcome.

H4: Intrinsic motivation positively affects perceived competence for learning.

H5: Curiosity is significantly correlated with intrinsic motivation.

H6: Autonomous regulation is positively correlated with learning outcome.

H7: Autonomous regulation is positively correlated with perceived competence for learning.

H8: Perceived competence for learning is positively correlated with learning outcome.

H9: Freedom of choice positively correlate with curiosity.

H10: Curiosity is significantly higher in the experiment group.

H11: Intrinsic motivation is significantly higher in the experiment group.

H12: Learning outcome is significantly higher in the experiment group.

H13: Perceived competence for learning is significantly higher in the experiment group.

Theory

Curiosity

Easy to learn, hard to master; curiosity is by many means a mystery. Though the roots, or evolutionary concept of curiosity and its necessity for human, or all animals, could be easily understandable, the definition of curiosity and its relevance past adolescence can be debated.

To clarify, this paper will cite Loewenstein (1994), which argue that curiosity was defined in the early 20th century as a wide range of behaviors collectively related to curiosity or exploratory behavior.

Early theories. In 1890, William James, was the first to propose that curiosity is a fundamental psychological motive including more than one dimension (cited by Kashdan et al., 2018). In 1927 the curiosity research ensued with Pavlov's observation of conditioned responses in dogs (cited by Loewenstein, 1994), specifically that the dogs would turn towards unusual sounds or sights. Pavlov attributed this behavior as an investigatory reflex. Similarly, Bühler, Hetzer, & Mabel (1928; cited by Loewenstein, 1994) discovered the same orientation reflexes in human infants and labeled it as curiosity. However, a modern understanding of the research would suggest that these findings have more in common with the term attention than with curiosity. The reasoning behind this conclusion is that attention, in contrast to curiosity, is absent of emotions and perhaps more important, lacks the intrinsic motivational aspects related to a cognitive appetite (Loewenstein, 1994). Already, a visible link between curiosity and intrinsic motivation can be found.

Definition. Other studies vary greatly in how curiosity is defined: curiosity is often presented by asking many unprompted questions (Peters, 1978), examining and manipulating objects of interest (Silvia, 2005; Reeve & Nix, 1997), investigate other people's thoughts, feelings, and behavior (Renner, 2006), and increasing the challenge of repetitive tasks (Sansone & Smith, 2000). Attempting to summarize such a variety of behaviors has resulted in the broadly defined term "curiosity".

Berlyne (1954; 1960) argued that there is two dimensions of curiosity: one extending between perceptual and epistemic curiosity, and one bridging specific and diversive curiosity. Perceptual curiosity can be defined as a drive which is aroused by novel stimuli but reduced by continued exposure to these stimuli. Epistemic curiosity is referred to as a desire for information, unlike perceptual curiosity which affect animals as well, epistemic curiosity is unique to humans. Specific curiosity is a need for a distinct piece of information. Diversive

curiosity can be linked to a general stimulation-seeking behavior, similar to characteristics of boredom (Berlyne, 1960). These four-way categorization produced by the two dimensions can be exemplified with specific perceptual curiosity as a child's attempt to solve a puzzle and diversive perceptual curiosity by exploratory behavior such as a child searching the attic. Both activities are engaged without reward or punishment. Specific epistemic curiosity can be exemplified by a students' search for a solution to a math problem and diversive epistemic curiosity can be wandering around looking for something to do.

Beswick defined curiosity in 1965 as "openness to unusual experience, the desire to understand novel experience and incorporate it into one's map of the world" (cited by Hogan & Greenberger, 1969). This definition is an example of diversive curiosity, and the fact that multiple definitions circle around Berlyne's theory may symbolize a paradigm shift from an attention-focused curiosity to an exploration-focused curiosity.

A more recent theory of curiosity developed by Reio (2012), states that there are two types of curiosity: cognitive and sensory. Cognitive curiosity is the desire for new information, whereas sensory curiosity is the desire for new sensations and stimulation. Reio (2012) continues to build upon Berlyne's theory by adding that specific exploration and diversive exploration allows solving a problem through seeking information (specific) and new sensory experiences to expand knowledge (diversive). Curiosity after this accord is the desire for new information, while sensory experiences motivates exploration of the environment (Reio, Petrosko, Wiswell, & Thongsukmag, 2006).

One of the few things many researchers agree upon during the last decades is the notion that it is archaic to consider curiosity a single dimension concept, ranging from uncurious to curious (Kashdan et al., 2018; Kashdan, Rose, & Fincham, 2004; Kashdan et al., 2009; Boyle, 1983; Berlyne, 1954; 1960; Hogan & Greenberger, 1969).

In a recent article by Kashdan et al. (2018), curiosity is defined as the recognition, pursuit, and desire to explore novel, uncertain, complex, and ambiguous events. Furthermore, they argue that in situations with feelings of interest, where there's a potential for learning, curiosity is often found. Curiosity can in some cases be the desire seek novel experiences just to see what happens.

Evolution. Curiosity can be viewed as a drive, or a source of motivation (Loewenstein, 1994), and in this paper, measured through the facets of exploration and absorption (Kashdan, Rose, & Fincham, 2004). The need to explore the environment is an innate desire with multiple purposes and benefits. Primarily, through exploratory behavior the

subject receives information and knowledge of the surroundings, which is essential for survival at a primal stage, thus it's arguable that curiosity is a necessity for all living animals. Though, curiosity is not only the act of exploration. Domenico & Ryan (2017) argues that exploration and play in humans are based on intrinsic motivations originating in ancient mammalian systems.

Similar Topics

With such a broad definition, curiosity indisputably shares similarities with a large array of other psychological terms. These includes openness to experience, novelty seeking, need for cognition, intrinsic motivation, tolerance for ambiguity, tolerance for uncertainty, frustration tolerance, and sensation seeking. Intrinsic motivation is particularly brought up in relation to curiosity in psychological research due to similarities and is along with sensation seeking (Byman, 2005) one of the most researched topics in this list that often include curiosity, especially with focus on the explorative aspect. For instance, the Self-Determination Theory includes curiosity as a subpart of intrinsic motivation rather than separate them (Ryan, 1982; Deci & Ryan, 1985; Deci & Ryan, 2000). Spielberger & Starr (1994) view curiosity as a unitary trait associated with feelings of interest. However, Deci & Ryan (1985; 2000) would argue that interest is a subcategory of intrinsic motivation. The epistemic curiosity scale of Litman (2008) measures interest and deprivation. Interest isn't only a factor in intrinsic motivation, consequently making the concepts of intrinsic motivation and curiosity more similar.

Motivation

Curiosity, as mentioned, can be a motivational force, but motivation as its own construct aspire to define vastly much more. Every action is motivated by a need or desire, whether it is biological, social, academically, or esthetical, drive-based or cognitive-based, we adjust our behavior to sate the need. To be motivated is defined by Ryan & Deci (2000a) as being moved, or energized, to do something. The Self-Determination Theory distinguish between different types of motivation based on what goals that produce actions: intrinsic motivation, extrinsic motivation and amotivation (Deci & Ryan, 1985).

Intrinsic motivation. In most cases related to curiosity, the motivational aspect of exploratory behavior, or absorption, is intrinsic. Intrinsic motivation is defined by Ryan & Deci (2000b) as the spontaneous tendency to "seek out novelty and challenges, to extend and exercise one's capacities, to explore, and to learn". Intrinsically motivated individuals engage in activities on own accord due to interest, or generally finding the activity satisfying.

Evolution. Intrinsic motivation was first discovered by Harlow's (1950) experimental study conducted on monkeys. Intrinsic motivation is important in terms of evolution and development as it exposes individuals to novel situations and consequently evoke the development of a diverse set of skills and competencies to be able to adapt to uncertain future situations (Ryan & Deci, 2017; cited in Domenico & Ryan, 2017). Intrinsic motivation would be of particular interest for those animals and humans that experience a protracted period of postnatal development and dwell in complex habitats (Wilson, 2000).

Extrinsic motivation. Though this study will emphasize intrinsic motivation, it is beneficial to understand the counterpart to intrinsic motivation, and coincidently the more common approach to motivation in schools. Extrinsic motivation refers to doing an activity in order to attain a separable outcome and refers to most activities people do (Ryan & Deci, 2000a).

Extrinsic motivation can be a great motivational force as it includes behavior based on the intent of receiving a reward for their effort (Ryan & Deci, 2000a). For instance, a student extrinsically motivated can study hard with intention to receive good grades. However, an intrinsically motivated student might study because he finds the reading material interesting or simply want to know more on the subject.

Behaviors like seeking knowledge or explorations that roots in extrinsic motivation are mostly reward-based, meaning that the behavior isn't triggered by an individual's natural desire to sate the desire to know more, but to gain something instrumental from an exterior source or to avoid punishment (Ryan & Deci, 2000b). This can for example be good grades in an academic scenario, or a prize in a scavenger hunt. However, there it is arguable that curiosity can be used for both intrinsic and extrinsic benefits. For instance, a man trapped on an island may employ intrinsic motivation or curiosity to explore the island for his own wonder. The knowledge gained can also be used for extrinsic purposes such as scavenging for food. As theorized earlier, using curiosity as a necessary means of survival may be the initial usage of concept, can be a reason of why we see this behavior in all kinds of animals, not only humans (Harlow, 1953; Wilson, 2000; Ryan & Deci, 2017; cited in Domenico & Ryan, 2017).

Today, motivation is rarely associated with survival nor foraging as in most societies such behaviors is not required for survival. Motivation, however, applies to nearly every aspect of our actions, including shopping for food.

Intrinsic motivated curiosity. The link between curiosity and intrinsic motivation have been debated for many decades. Loewenstein (1994) argued that individuals seek

information because they believe they will find it interesting, not because the absence of information is a deficiency; cognition itself, even without physiological need, can motivate curiosity. Deci and Ryan (2008) supports this view explaining that Self-Determination Theory include the assumption that humans are naturally curious because it is both rewarding and satisfying.

Self-Determination Theory

Self-determination theory (SDT) suggests that every individual have a need for competence (Deci & Ryan, 1985, 2000). SDT further proposes that the psychological needs for autonomy, competence and relatedness are basic requirements for human well-being and intrinsic motivation (Schüler, Sheldon, & Fröhlish, 2010). Autonomy refers to the need of actively determine own behavior and experience mastery at work without influencing others. Competence reflects the need for efficient use of energy and effectiveness at work, and to experience capability to complete the work by themselves. Lastly, relatedness assesses the need to have meaningful relations with others (Arshadi, 2010; Ryan, Sheldon, Kasser, & Deci, 1996).

Deci, Connell and Ryan (1989) state that to be self-determined involves experiencing a sense of choice regarding initiating and regulating one's actions. Deci et al. (1989) furthermore argues that initiation and regulation of intentional behavior could be determined either as informational or controlling behavior. Informational aims towards supporting autonomy and competence, whereas controlling refers to pressuring one to think, feel or behave in specified ways. Experiencing an input as informational could encourage self-determination. However, finding it controlling could decrease self-determination. Similar to Maslow's hierarchy of needs, SDT postulate that fulfilling one's innate psychological needs for autonomy, competence and relatedness is essential for actualizing their full potential and growth (Deci & Ryan, 2002).

Being self-determined have many advantages. Former studies have linked high self-determination to enjoy activities more, have higher well-being and show greater adaptive behavior than those with low self-determination (Puente & Anshel, 2010). The SDT propose that every individual have an active tendency toward psychosocial growth and integration, which motivates them to seek challenges and discover novel perspectives (Deci & Ryan, 2002). Domenico & Ryan (2017) argue that within the SDT, competence and autonomy are essential in individuals' inclination to seek out challenges, to be curious and interested, and to

develop and express their capacities. Upon support by these needs, intrinsic motivation may flourish.

To present an example of how curiosity and intrinsic motivation collaborate, and plays a role in our daily life, assume that a person is exploring the nature hoping to find something novel and unique to photograph. The origin of the motivational aspect of the exploratory behavior is unknown and can be rooted in both intrinsic and extrinsic motivation. If the photographer does this as a hobby and seek no extrinsic reward, but explore the nature for the sake of the activity in itself, it is safe to say that the motivational condition is intrinsic. If the photograph is the cause for taking the stroll, extrinsic motivation is utilized. However, if we assume that the photographer is motivated by the enjoyment of the activity, is it curiosity or intrinsic motivation that cause the exploratory behavior? Moreover, considering the concepts that roots in more than one theoretical framework, could interest only be a product of intrinsic motivation or could interest be stimulated through curiosity?

Amotivation. Amotivation is the third variation of motivation according to the SDT and explain the lack of motivation or motivational behavior. Amotivation results from not valuing an activity (Ryan, 1995), not feeling competent to do it (Deci, 1975; cited by Ryan & Deci, 2000a), or believing that it will not yield a desired outcome (Seligman, 1975; cited by Ryan & Deci, 2000). Upon experiencing low motivation, self-regulation may be needed to complete or engage in activities.

Self-Regulation

According to Milyavskaya, Inzlicht, Hope, and Koestner (2015), self-regulation is the interaction between controlled and impulsive processes. It plays an important part of our lives, influencing our diets, productivity at work, resisting angry outburst in an argument and everything that involves holding back our impulses. Regarding this thesis, self-regulation is assessed with emphasis on academic behavior and motivation, rather than all manner of goal pursuit.

The SDT differentiates between types of behavioral regulation and in which degree they count as autonomous or controlled functioning and utilize four subtypes of self-regulation: external regulation, introjected regulation, identified regulation, and lastly intrinsic motivation. External regulation is the least internalized form for regulation and impose from the outside. Introjected regulation refers to utilize regulation without accepting it as one's own. Identified regulation directs to accepting the value of the activity as personally important. Intrinsic motivation is self-determined and autonomous (Ryan & Connell, 1989).

These subfactors exemplify how varied self-regulation can be, and that intrinsic motivation is employed by other concepts as well, which in turn further complicates the already difficult situation of taxonomy between curiosity and intrinsic motivation. However, this study will only employ the autonomous and controlled subscales of self-regulation, as they should suffice to explain their variation on learning without an in-depth examination of self-regulation.

A similar definition comes from Pintrich (2000) who defined self-regulation learning as an active, constructive process where learners set goals for their learning and then attempt to monitor, regulate and control their cognition, motivation, and behavior, guided and constrained by their goals and the contextual features in the environment. Self-regulated learning emphasizes autonomy and control by the individual who attempts to regulate the behavior towards goal attainment.

While the definitions are slightly different, motivation is mentioned in both definitions, and plays a large role in both self-regulation and learning. Thus, there is no surprise that the SDT branches into self-regulation.

Learning

Assuming that curiosity motivates behavior that obtain and assess information, this paper will emphasize the bridge between curiosity and learning. Psychosocial theorists such as Erikson (1968) argue that curiosity and exploration is associated with identity formation and learning (cited by Reio, 2012). Furthermore, they argue that internal forces influence individual development through unique feelings, interests, and needs. Piaget, from a cognitive angle, proposed that curiosity is a prerequisite for the construction of knowledge due to stimulating acquisition of novel information and seeking new stimuli (Reio et al., 2006).

Vallerand and colleagues (1992) argue that intrinsic motivation is one of the more important psychological concepts in education. Due to approaching activities based on interest, intrinsically motivated individuals learn, develop and expand their abilities and skills (Deci & Ryan, 1985). In higher education, intrinsically motivated students find academic assignments worthwhile and meaningful, which in turn contribute to search for more forms of coursework (Brophy, 1983). Thus, it is not far-fetched that intrinsic motivation benefit learning and that Vallerands research (1992) have strong support from later studies (Flum & Kaplan, 2006; Reio, Petrosko, Wiswell, & Thongsukmag, 2006; Reio, 2012; Ye, Ng, Yim, & Wang, 2015; Goldman, Goodboy, & Weber, 2017).

Goldman et al. (2017) notes that self-determination theory is a helpful tool to understand college students' intrinsic motivation to learn. Reeve (2002) argues that intrinsically motivated students have showed increased results in academic settings compared to extrinsically or amotivated individuals, a similar result was discovered by Miserandino (1996).

Evolution. Deci & Ryan (2000) pointed out that "if people did not experience satisfaction from learning for its own sake (but instead needed to be prompted by external reinforcements) they would be less likely to engage the domain-specific skills and capacities they inherited, to develop new potentialities for adaptive employment, or both". To illustrate, people would be less likely to discover alternative food sources or taking interest in skills that have no apparent use, such as learning to play an instrument. Consequently, this theory seems to assume a link between learning and curiosity, intrinsic motivation or other concepts that promotes enjoyment as well as knowledge.

Method

Theory

A quantitative approach was selected for this study, a choice heavily influenced by former research on the topic of curiosity (Loewenstein, 1994; Kashdan et al., 2004; Berlyne, 1954; 1960) intrinsic motivation (Deci & Ryan, 2000; Ryan & Deci, 2000a; 2000b; Vallerand et al., 1992) and their facet-based measurements. A questionnaire was utilized due to the numeric and easily transformable responses. Though limitations of surveys and all self-reported data can be meaningfully disruptive, this was selected as the best alternative to measure correlational significance between the variables. Furthermore, the study employs a pre-test/post-test design: an experimental design with three groups and one intervention.

The study employs samples of standardized questionnaires, only adding one item with one question of own design: learning outcome. As mentioned, learning will be addressed from two perspectives; (1) learning outcome, a simple measure of the students' perceived learning outcome or expected learning outcome, and (2) perceived competence for learning, a SDT variation of learning where the questionnaire measures the students' confidence that they are capable to learn or master the material.

Scales

Curiosity and exploration inventory (CEI-I). The curiosity and exploration inventory is designed by Kashdan, Rose, & Fincham (2004) in order to measure participants' recognition, pursuit and integration of novel and challenging stimuli and experiences. The

scale consists of two subscales: (1) exploration, which mainly measures how individuals pursue novelty, and (2) absorption, referring to the immersion and dedication to a task.

CEI-II. The Curiosity and Exploration Inventory II was developed to address limitations regarding willingness to embrace and manage the contact with novelty and uncertainty. In this version the absorption scale was dropped in favor of two new subscales called stretching and embracing, which equally well could present the psychometric properties of the absorption subscale. Stretching refers to individual motivation to seek knowledge and new experiences, whereas embracing focuses on the willingness to enjoy new, uncertain, and unpredictable events in the everyday life (Kashdan et al., 2009).

This study, however, used the first version of the CEI. There were multiple reasons why, but the most prominent ones are that there was a desire to minimalize the size of the questionnaire to leave more room for the students to apply their curiosity and gain knowledge. Other reasons include that the CEI-I offer more variety from the IMI-scale than that of the CEI-II. The stretching scale offer many similarities with intrinsic motivation, which defeats much of the purpose with this study, which in many ways is to separate curiosity and intrinsic motivation to fully understand their separate outcome on learning.

Perceived competence for learning scale. One of the key psychological needs within the Self-Determination Theory, developed by Deci & Ryan (1985), is competence, accompanied by relatedness and autonomy. Competence, or perceptions of competence for learning, in regards of an activity is theorized to be of great importance because it facilitates individuals goal attainment and provide satisfaction from participating in an activity which they feel successful. This study employs the perceived competence for learning scale originally created and used by Williams & Deci (1996) on medical students.

Learning self-regulation questionnaire. As with the perceived competence scale, the self-regulation questionnaire is also created by Williams & Deci (1996) for use on medical students. In contrast to the academic self-regulation questionnaire which is intended for use with children, the learning self-regulation questionnaire is for older students. The Self-Determination Theory differentiates between types of behavioral regulation in regard to whether they represent autonomous or controlled functioning. Intrinsic motivation is per the SDT self-determination, whereas extrinsically motivated activity is generally controlled, or less autonomous. To measure this regulation, the questionnaire consists of two subscales: (1) autonomous regulation, measuring the intrinsic motivation, and (2) controlled regulation, which emphasize the extrinsic motivation in the activity.

Learning outcome. Learning outcome is meant to represent to what degree the student perceived that he or she experienced learning during the class. Though other scales are targeted towards learning, a simplified item was desired to easily separate the groups in terms of perceived learning outcome.

Intrinsic motivation inventory. The purpose of the intrinsic motivation inventory is to assess individuals subjective experience related to the target activity in a laboratory experiment. It is a multidimensional measurement which assess participants' interest, perceived competence, effort, value, felt pressure and tension, relatedness, and perceived choice. The perceived competence differs from the competence measurement created by Williams & Deci (1996) which emphasize learning and hope for achieving desired results, thus being more directed to the future, while this inventory focuses on the participants feelings of competence in the present. However, it expected that the two perceived competence scales will significantly correlated due to their similarities.

The intrinsic motivation inventory consists of too many items for a short questionnaire, consequently the effort, felt pressure/tension, and relatedness scales were dropped from this study. The interest subscale can be considered a self-report measure on intrinsic motivation (Deci, Eghrari, Patrick, & Leone, 1994) and is the only subscale that directly assesses intrinsic motivation, despite the inventory name. Perceived competence and perceived choice are both concepts theorized to be positive predictors of self-report and behavioral measures of intrinsic motivation.

Removed scales. Pressure was removed from the survey because it's negative predictor of intrinsic motivation and there wasn't necessary for a third predictor. Perceived choice would perhaps be a typical subscale to eliminate instead of pressure because of the double positive predictors, but in this study perceived choice was assessed due to the nature of the experiment intervention where the participants were given free choice of approaching a topic.

Effort is a separate variable related to motivation which was dropped in favor of other variables determining more specific motivations.

Concluding, relatedness is a subscale of importance to the SDT in regards of interpersonal interactions. However, since this study deals with the subjective perceptions of curiosity, motivation and learning, this subscale was also dropped from the questionnaire.

Measurement Selection

To address the broad scope curiosity, this study employs measures of curiosity (Kashdan et al., 2004) and intrinsic motivation (Deci et al., 1994) with focus on facets. The thought behind this is that curiosity and intrinsic motivation share similarities, such as the facet exploration, which is according to the SDT a typical result of intrinsic motivation (Williams & Deci, 1996) and the facet interest, which in the measure developed by Ryan (1982) is a subscale of intrinsic motivation, however, Naylor (1981), Lowry & Johnson (1981), and Loewenstein (1994) would argue that interest is directly correlated with curiosity. Consequently, there are no easy manners to measure curiosity and uphold content validity and construct validity.

Learning too, is not easy to conceptualize in terms of measurement, thus two separate aspects of learning are addressed; (1) perceived competence for learning, which as stated, measure an individual's perception of one's own ability to learn; and (2) learning outcome, a simple measure of perceived learning outcome.

Self-regulation is also theorized to have an impact on learning, especially the autonomous facet, which shares similarities with intrinsic motivation and consequently plays an important role for the research performed by this study.

All standardized questionnaires were translated to Norwegian.

Design

After discussing the study with a teacher at Sandvika Videregående Skole (high school) we agreed that the experiment intervention would be self-learning of a curriculum-based topic, specifically culture radicalism in the middle war period. The concept is that by introducing a new topic, but not give a full lecture on it, would leave the students wanting to know more. This idea is based on Loewenstein's information gap theory (1994), which argue that curiosity arise with a gap in knowledge, and those afflicted would desire to know more, and decrease the information gap.

The design was to some degree inspired by Agina's study (2012) in which the children chose their own activity. The main differences are that this study uses older participants and that the activity is designed to evoke information-gap, not interest-based activities. The students in the experiment were free to choose their own progression and they were free to not do research on the topic if they did not want to.

The control group would be a regular class per design of the teacher, where the researcher of the study would only observe in addition to handing out surveys. The control

and experiment groups would be the same class, different days, with post-test surveys handed out on both occasions, however the pre-test was only employed the first day. The class consisted of 27 students, with an even distribution of genders. However, not all were present, 22 students scored the pre-test, 21 scored on the experiment group post-test, and 14 scored the control group post-test. The class suffered a heavy decrease in attending students the second day, which may have affected the validity and reliability of the experiment.

The students were handed three almost identical surveys. The first was presented and completed before the class, acting as a pre-test. This questionnaire would act as basis for the class, or a control before any intervention. There was only one pre-test conducted as there was not expected to be any difference between the one-day interval between the surveys. After the intervention, in which the students freely explored the topic of culture radicalism in the interwar period, the participating students filled out the second form. The day after, at the end of the class, a third survey was completed as a control. The purpose was to define any difference between the intervention class and a class without any meddling from the researcher.

Design limitations. Although there was a desire to be able to generalize the research, the nature of the pretest-posttest design heavily limited the possibility of a population large and diverse enough for generalization. However, with enough resources, it is highly recommended for future research to increase the sample size. Currently, due to the limited sample size, this study is unable to generalize the findings to a larger population.

Selection

The group consisted of high school students at the age of 18. Purely coincidental, all participants were of the same age. This group was selected based on lack of options, as several schools and teachers had been contacted, but not been available. The selection was also limited to high school students and younger, as their attendance to school would be affected by obligation, not voluntariness. The reasoning is that students of higher educations, such as university or college, more often chose to be there, thus the significance of curiosity on learning would be larger than of those forced to do certain classes, especially since a lot of students may have selected a course that they are curious about or interested in. The study will not rule out the possibility that a younger age among the participants would increase reported levels of curiosity.

The group selected for the study was the 4th year of a career-directed course. The test was carried out January 22-23. Note that the surveys were filled out by the same class on different days.

Age. Regarding the age of the subjects, measuring curiosity was mostly important in the context of learning, thus any age between 6 and 25, or possibly older, could be relevant if they attended an institution for learning. However, due to practical and legal reasons, the preferred age would be between 16 and 18. Specifically, due to rulings by the "Regionale komiteer for medisinsk og helsefaglig forskningsetikk" (REK), students below the age of 16 are not allowed to perform a survey without authorization of a legal guardian. To remain on the safe side, both REK and "Norsk senter for forskningsdata" (NSD) were contacted during the previous semester to check if approval was necessary for the study at hand.

6-point Scale

The students scored all their answers on a 6-item scale. The 6-item scale was selected in favor of the 7-item Likert scale to remove passive answers. The original questionnaires varied between 4-item to 7-item scales. It is noteworthy that some students saw fit to mark their answer between two items, indicating passiveness to the question. The results may have been different if examined through a 7-item scale.

The Experimental Procedure

Intervention group. After a short introduction to the study and survey, including their rights and anonymity, the students were handed the pre-test survey. After ten minutes, everyone had completed the questionnaire. The teacher then gave a short introduction to the topic of the class to explain what the students were to learn about. Then, the intervention started by allowing the students to freely research the subject on their own. This went on for a class hour of 45 minutes before the students were handed out the post-test. In the meanwhile, the researcher acted only as observer.

Control group. Unlike the intervention group, this class went as a normal class hour, and the students went straight to work. The researcher acted as an observer until the end of the class. After roughly 45 minutes the students were handed out a post-test survey. There was no pre-test survey, as the pre-test addressed the individuals' expectation and experience of the class in general and was not intended to address the participants' experience and expectations on that particular day. However, due to many uncontrollable factors, the results of the pre-test may have varied greatly, and it is possible that the validity of the test would increase by employing the pre-test both days and use the mean scores.

Analysis

Survey. The survey handed out was created for this paper, but used standardized tests formerly created and applied in similar field of science. In total, 5 measures were used; (1) Intrinsic Motivation Inventory, (2) Curiosity and Exploration Inventory, (3) Learning Self-Regulation Questionnaire, (4) Perceived Competence for Learning Scale, and (5) Learning Outcome. The last measure was as mentioned of own design.

SPSS. This study used the statistical tool SPSS to input data and calculate correlations, statistical strength, and determine the effects between groups.

Data Collection

Information gathering. This study primarily used college-supplied search engines to find relevant articles and studies, specifically Oria. However, Google and Google Scholar were also used, although to a lesser extent. Books from the previous years were also utilized, in most cases the references were used to find the original material of which the books summarized. One book in particular by Andy Field (2014) was employed to better understand results acquired from SPSS.

Errors

A possible source of error may stem from the fact that the students could forego the assignment and rather spend their time on social media or other unrelated topics. However, it was mentioned that the activity was voluntary, and the students were allowed to proceed how they wanted, and that may, in turn, impact their subjective learning outcome.

Another known error is that there were some questions about the survey and what activity it referred to, leading to another brief explanation. Some, however, might not have paid attention to the second announcement. It can further be emphasized that the students were not as used to surveys as the researcher, thus reducing the reliability of the survey.

Idling. To further examine the first possible error: due to the nature of the experiment, allowing students to freely approach the subject, non-academic activity, such as social media, may have affected the experiment. All students used computers and internet, so idling or non-academic activity was expected to some degree. However, since there was no monitoring on this deviant activity, it is unknown if, or how much, non-academic activity affected the study. It is noteworthy to mention that computers and internet was employed both in the experiment group and in the control group. While the idling in the control group may represent normality, idling in the experiment group indicates that the intervention failed to inspire an action-worthy information gap.

Results

Descriptive Statistics

Descriptive statistics displays the number of total participants as 57. Note that this number refers to the same class, but as a collection of all three tests. The pre-test group consisted of 22, the post-test for the experiment group had 21 participants, and the post-test control group had 14 members. To clarify the numbers, the pre-test and post-test experiment group was conducted the same day, with loss of one participant due to sickness. The day after, the post-test control group was tested at the same class. However, only 14 of the 27 members of the class attended.

The gender distribution skewed slightly more towards the females, with a total of 35 female participants, and 21 male participants. One participant did not submit a gender.

Descriptive Statistics

TestGroup		N	Minimum	Maximum	Mean	Std. Deviation
Pre-test	TestGroup	22	1	1	1,00	,000
	Gender	22	1	2	1,41	,503
	Age	22	18	18	18,00	,000
	Interest	22	1,66	4,66	3,1641	,78824
	PercComp	22	2,33	5,33	4,0877	,84290
	PercChoice	22	1,00	4,00	2,6018	,94110
	Value	22	1,66	5,33	3,4795	,95860
	PercCompL	22	1,66	5,66	4,3595	1,30402
	AutoReg	22	2,33	5,00	3,7845	,87115
	ContReg	22	1,66	5,33	3,6482	,97285
	Explor	22	3,00	5,66	4,1627	,83350
	Absorp	22	2,33	5,66	3,9823	,90478
	LearnOut	22	1	5	3,55	1,371
	Valid N (listwise)	22				
Post-test Control group	TestGroup	14	2	2	2,00	,000
	Gender	13	1	2	1,31	,480
	Age	13	18	18	18,00	,000

	Interest	14	1,33	5,00	3,1393	1,14585
	PercComp	14	2,00	5,33	4,0693	,87831
	PercChoice	14	1,00	4,66	2,4500	1,09789
	Value	14	2,00	4,66	3,3057	,89970
	PercCompL	14	1,66	5,66	4,3786	1,25441
	AutoReg	14	2,66	4,66	3,9236	,71831
	ContReg	14	2,33	5,00	3,9250	,76367
	Explor	14	2,33	6,00	3,8293	1,05203
	Absorp	14	2,00	5,66	3,3314	1,06000
	LearnOut	14	1	5	3,21	1,424
	Valid N (listwise)	13				
Post-test Experiment group	TestGroup	21	3	3	3,00	,000
	Gender	21	1	2	1,38	,498
	Age	21	18	18	18,00	,000
	Interest	21	1,00	4,33	3,1081	,93842
	PercComp	21	3,00	5,33	4,1229	,58191
	PercChoice	21	1,00	4,33	2,6962	,96488
	Value	21	2,00	5,00	3,4738	,85340
	PercCompL	21	2,00	6,00	4,2843	1,13217
	AutoReg	21	2,33	4,66	3,7110	,60751
	ContReg	21	2,00	5,00	3,7105	,72427
	Explor	21	2,66	6,00	3,9010	,79704
	Absorp	21	2,00	5,66	3,7438	1,04774
	LearnOut	21	1	5	3,38	1,161
	Valid N (listwise)	21				

Table 1: Descriptive Statistics of test groups in split file.

As the table show, the students' means are relatively similar between many subjects. For instance, Perceived Competence for Learning shows m=4.36, N=22, in the pre-test group, m=4.38, N=14, in the control group, and m=4.28, N=21 in the experiment group. The small

difference in means suggest that there was little difference in effect between the test groups. The results also displayed that the control group experienced a greater mastery of learning than the pre-test and experiment group. However, some variables such as exploration varies more visibly between groups as indicated by Figure 1.

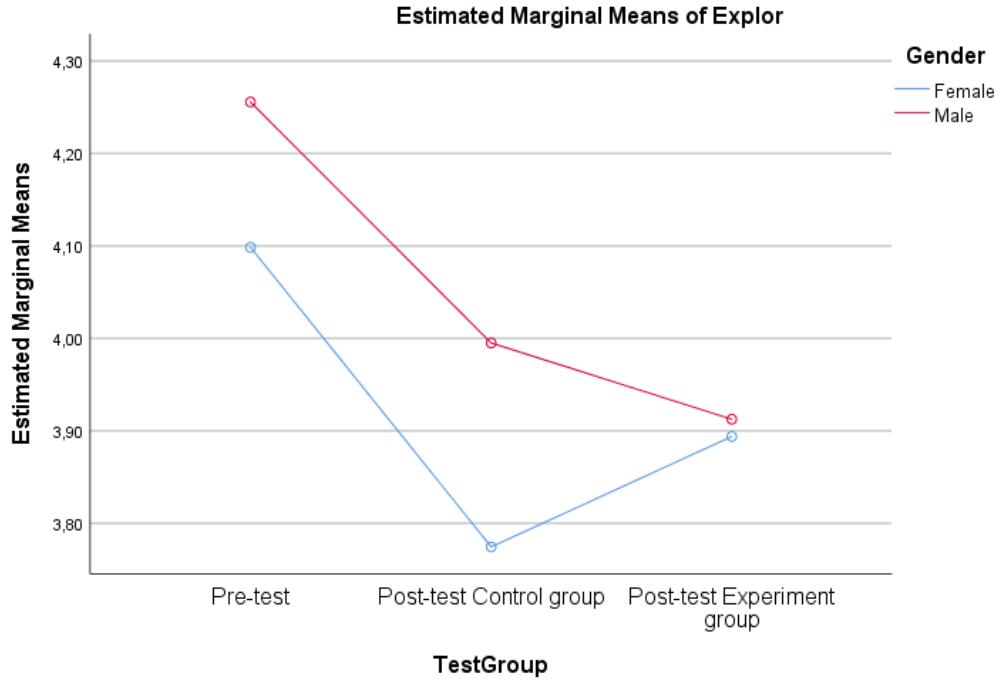

Figure 1: Estimated Marginal Means of Exploration across the test groups separating between genders.

While the study does not explicitly attempt to address variety between genders, some variables, such as Learning Outcome, displays a large variation between genders that is worth noting. The means shown in Figure 2 indicates that the male population of the sample had a bigger reported Learning Outcome in the control group and experiment group than in the pre-test group. However, the female population of the sample benefits more from the pre-test group than the control group and experiment group.

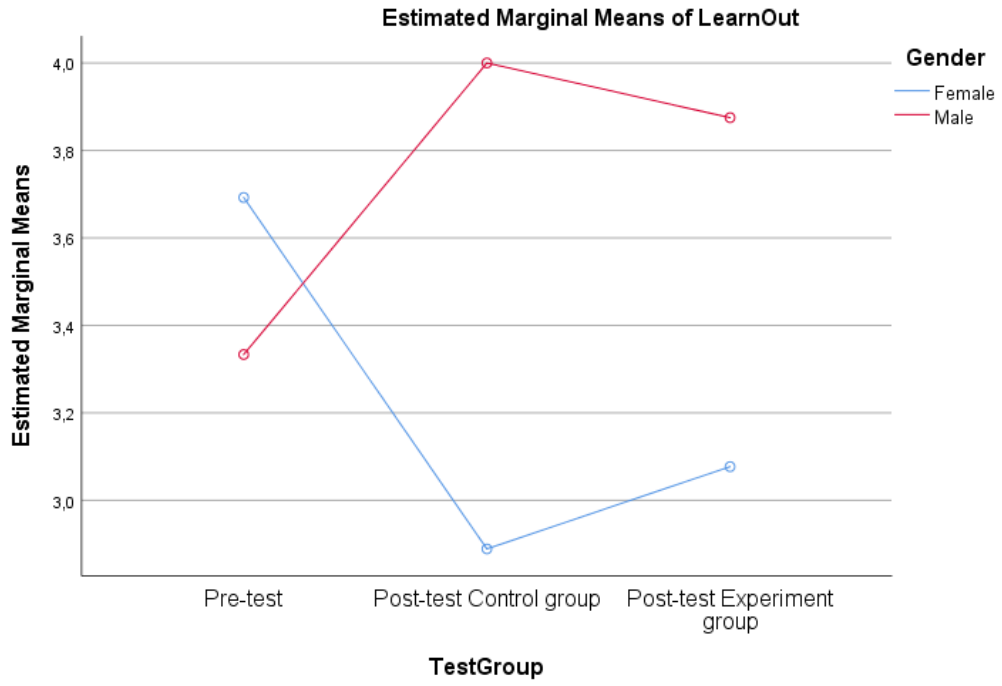

Figure 2: Estimated Marginal Means of Learning Outcome across test groups separating between genders.

Gender Scores

The descriptive statistics of the female group indicated a lower mean score than the male group in Interest (mean=2.86 vs. mean=3.56), Perceived Choice (mean=2.40 vs. mean=2.99), Value (mean=3.26 vs mean=3.77), and somewhat lower on Perceived Competence for Learning (mean=4.23 vs mean=4.47), Absorption (mean=3.65 vs mean=3.90), and Learning Outcome (mean=3.26 vs mean=3.67). However, the female participants scored a higher mean on Perceived Competence (mean=4.14 vs mean=3.94), Autonomous Regulation (mean=3.83 vs mean=3.69), Controlled Regulation (mean=3.92 vs mean=3.39). The variables Perceived Competence and Exploration remained similar between the groups.

In any case, a measure of correlations is necessary to determine any significant relation between variables. Note that any significant results do not determine causality.

Correlations

When performing a Pearsons *r* test on the total sum of participants, not between groups, in regard to the correlational values of the concepts, opposite to subfactors, Curiosity shows a strong correlation with intrinsic motivation (p=0.000, r=0.514, N=57), but not with Learning Outcome or Self-Regulation. However, Intrinsic Motivation were correlated with

Learning Outcome (p=0.000, r=0.565, N=57). Self-Regulation only correlated with Learning Outcome (p=0.014, r=0.324, N=57), if p<0.05. The other stated correlations were true if p<0.01.

These results indicate a linear relationship between Curiosity and Intrinsic Motivation, Learning Outcome and Intrinsic Motivation, and between Learning Outcome and Self-Regulation. Similar findings were discovered when addressing the monotonic relationship between the factors through Spearman's rho, and neither of the values change from or to significant values, suggesting that there is no linear nor monotonic relationship between Curiosity and Learning Outcome in this sample selection.

However, Curiosity significantly correlated with Perceived Competence for Learning (p=0.000, r=0.486, N=57).

Correlations Split File

Pre-test. When examining the different groups, only Self-Regulation displayed a significant correlation with Learning Outcome if p<0.05 (p=0.022, r=0.484, N=22). This suggest that the students applied regulatory behavior when approaching learning before any intervention by the educator or researcher. Furthermore, it displays that Curiosity nor Intrinsic Motivation affected the students approach to learning before engaging in learning activities or strategies.

However, as depicted in Table 2, Curiosity was positively correlated to Intrinsic Motivation (p=0.047, r=0.428, N=22) and Perceived Competence for Learning (p=0.011, r=0.534, N=22) if p<0.05. Intrinsic Motivation also correlated with Perceived Competence for Learning (p=0.029, r=0.464, N=22). This indicate that though Curiosity did not show a correlation with Learning Outcome, or expected Learning Outcome since it was the pre-test, there was a relationship between Curiosity, Intrinsic Motivation and Perceived Competence for Learning, or in other terms, a relationship with curiosity and the student's belief that he or she could master the course material.

Correlations

TestGroup			LearnOut	Curiosity	Intrinsic Mot	SelfReg	PercCompL
Pre-test	LearnOut	Pearson Correlation	1	-,417	,396	,484*	-,045
		Sig. (2-tailed)		,053	,068	,022	,841

		N	22	22	22	22	22
	Curiosity	Pearson Correlation	-,417	1	,428*	-,032	,534*
		Sig. (2-tailed)	,053		,047	,888	,011
		N	22	22	22	22	22
	IntrinsicMot	Pearson Correlation	,396	,428*	1	,210	,464*
		Sig. (2-tailed)	,068	,047		,348	,029
		N	22	22	22	22	22
	SelfReg	Pearson Correlation	,484*	-,032	,210	1	,401
		Sig. (2-tailed)	,022	,888	,348		,065
		N	22	22	22	22	22
	PercCompL	Pearson Correlation	-,045	,534*	,464*	,401	1
		Sig. (2-tailed)	,841	,011	,029	,065	
		N	22	22	22	22	22

Table 2: Correlations of the main variables without facets in the Pre-test group.

Upon subfactor inspection of the concept items, Learning Outcome significantly correlated positively with Interest (p=0.014, r=0.514, N=22) and Value (p=0.029, r=0.466, N=22), both subfactors of Intrinsic Motivation. The Absorption subfactor of Curiosity surprisingly displayed a negative effect on Learning Outcome in the pre-test group (p=0.014, r=-0.517, N=22). This finding suggest that absorption of a topic negatively impacts learning, or alternatively, higher learning outcome negatively affects the absorption facet of curiosity.

Post-test control group. In contrast to the pre-test, the post-test control group demonstrate a significant correlation between Intrinsic Motivation and Learning Outcome (p=0.000, r=0.840, N=14). Learning Outcome no longer significantly correlate with Self-Regulation (p=0.176, r=0.384, N=14). These findings suggest that during the class hour, the students no longer experienced the need to apply self-regulatory behavior to enhance learning, but could suffice with intrinsic motivation, most likely deriving from the teacher learning strategies. Intrinsic Motivation also results in positive correlation with Perceived Competence for Learning (p=0.049, r=0.534, N=14), however Curiosity does not. In fact, Curiosity does

not display any significant correlational values with any of the concepts in the post-test control group, however upon examining subfactors of the concepts, Exploration significantly correlated with Perceived Competence for Learning (p=0.029, r=0.582, N=14). Furthermore, Learning Outcome correlated with Autonomous Regulation (p=0.044, r=0.544, N=14). Interestingly, Learning Outcome correlated with every subfactor of the Intrinsic Motivation item with the only exception being Perceived Competence.

Post-test Control group	LearnOut	Pearson Correlation	1	,197	,840**	,384	,224
		Sig. (2-tailed)		,500	,000	,176	,442
		N	14	14	14	14	14
	Curiosity	Pearson Correlation	,197	1	,470	,213	,440
		Sig. (2-tailed)	,500		,090	,465	,115
		N	14	14	14	14	14
	IntrinsicMot	Pearson Correlation	,840**	,470	1	,350	,534*
		Sig. (2-tailed)	,000	,090		,219	,049
		N	14	14	14	14	14
	SelfReg	Pearson Correlation	,384	,213	,350	1	,160
		Sig. (2-tailed)	,176	,465	,219		,584
		N	14	14	14	14	14
	PercCompL	Pearson Correlation	,224	,440	,534*	,160	1
		Sig. (2-tailed)	,442	,115	,049	,584	
		N	14	14	14	14	14

Table 3: Correlations of the main variables without facets in the Post-test control group.

Post-test experiment group. As with the post-test control group, Intrinsic Motivation significantly correlated with Learning Outcome if p<0.05 (p=0.019, r=0.507, N=21). As with the pre-test Curiosity showed significant relationship with Intrinsic Motivation (p=0.002, r=0.645, N=21) and Perceived Competence for Learning (p=0.013, r=0.531, N=21). Furthermore, Intrinsic Motivation correlated positively with Perceived Competence for Learning (p=0.014, r=0.526, N=21). Self-Regulation, however, did not correlate with any other concepts in the post-test experiment group.

Upon closer inspection of the subfactors of the items, the only significant correlation with Learning Outcome was that of Interest, one of the subfactors of Intrinsic Motivation

(p=0.005, r=0.586, N=21). When addressing Perceived Competence for Learning, besides Perceived Competence, Value was positively correlated (p=0.035, r=0.462, N=21), and so was Exploration (p=0.001, r=0.679, N=21).

Post-test Experiment group	LearnOut	Pearson Correlation	1	,289	,507*	,069	,192
		Sig. (2-tailed)		,205	,019	,766	,405
		N	21	21	21	21	21
	Curiosity	Pearson Correlation	,289	1	,645**	,229	,531*
		Sig. (2-tailed)	,205		,002	,317	,013
		N	21	21	21	21	21
	IntrinsicMot	Pearson Correlation	,507*	,645**	1	,188	,526*
		Sig. (2-tailed)	,019	,002		,414	,014
		N	21	21	21	21	21
	SelfReg	Pearson Correlation	,069	,229	,188	1	,160
		Sig. (2-tailed)	,766	,317	,414		,487
		N	21	21	21	21	21
	PercCompL	Pearson Correlation	,192	,531*	,526*	,160	1
		Sig. (2-tailed)	,405	,013	,014	,487	
		N	21	21	21	21	21

Table 4: Correlations of the main variables without facets in the Post-test experiment group.

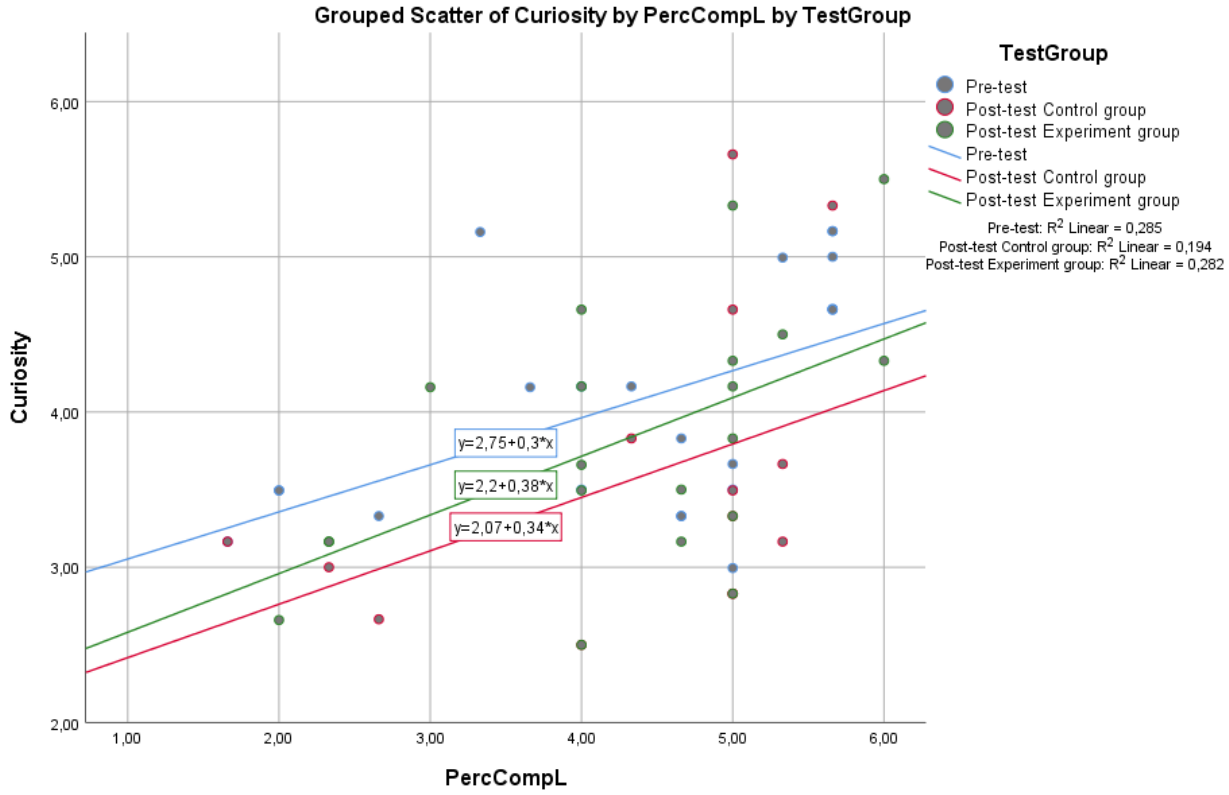

Figure 3: Scatterplot depicting the fit lines of Curiosity and Perceived Competence for Learning between test groups.

Spearman's rho. Upon examination of the monotonic relationship between the factors, no items were significantly different from the linear relationship examined in the Pearson's *r*.

As indicated by Table 4, Curiosity shows a significant correlation with Perceived Competence for Learning.

Correlations

			PercCompL	Curiosity
Spearman's rho	PercCompL	Correlation Coefficient	1,000	,524**
		Sig. (2-tailed)	.	,000
		N	57	57
	Curiosity	Correlation Coefficient	,524**	1,000
		Sig. (2-tailed)	,000	.
		N	57	57

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

Table 5: Spearman's *r* between Curiosity and Perceived Competence for Learning.

Test of Normality

In test of normality, the distribution of exploration scores was normal in Pre-test and Control group, not Experiment group (p=0.046, df=21), on the Kolmogorov-Smirnov test. None were significant on the Shapiro-Wilk test. The Q-Q plot does not show major problems with kurtosis, meaning that the dots does not stray too far below or above the line. There are a couple outliners in the post-test groups, two outliners in the control group and one in the experiment group. In the pre-test, the quantiles fall close to the diagonal line, indicating a good normal distribution. Reviewing the absorption values, the clearest distribution lies with the experimental group, with a good pre-test score as well. The control group is more spread than the rest. The control group is significant in the test of normality (p=0.008, df=14), whereas the other two are not (both p=0.200). Regarding learning outcome, all tests were significant.

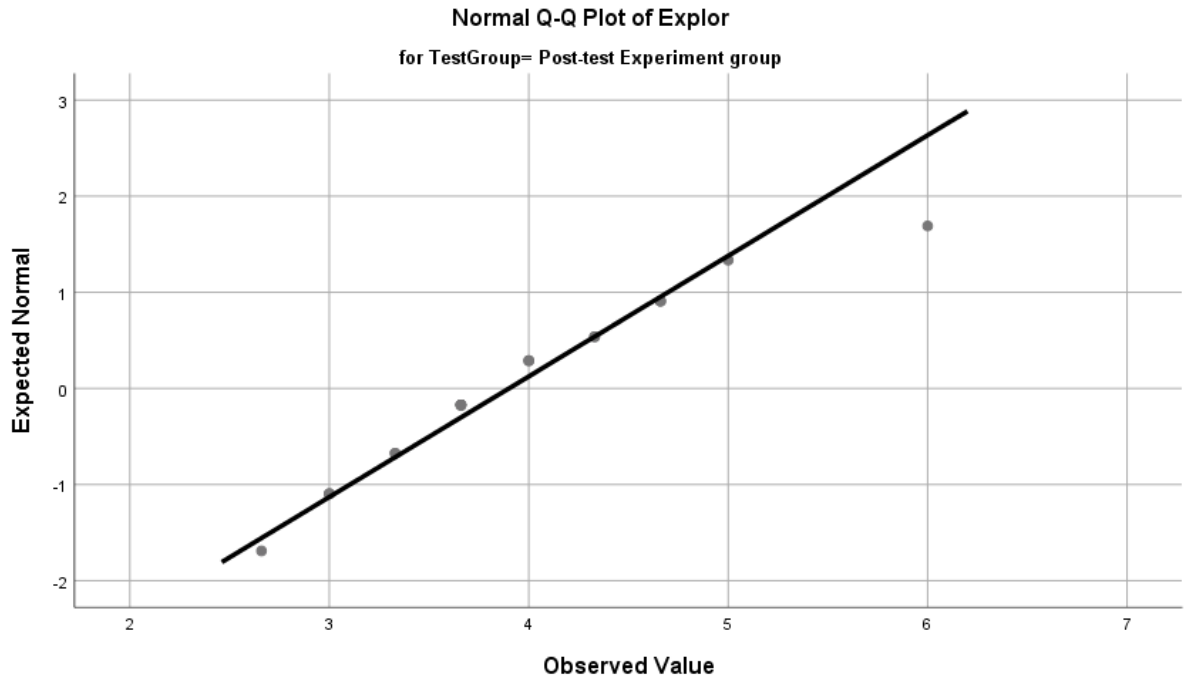

Figure 4: A Q-Q Plot of Exploration in the Experiment group.

Regression

In the regression model between curiosity and learning outcome, the analysis showed a small F value (F=0.033) indicating that the sample size is too small, or the null hypothesis is true.

On perceived competence for learning. In the regression model on curiosity as predictor to Perceived Competence for Learning (PCL), F=17.052, p=0.000. This indicates

that there is less than 0.1% chance that the *F*-ratio would occur if the null hypothesis were true. Curiosity can account for 22.3% of the variation in PCL (Adjusted R^2=0.223). Beta=0.486.

Intrinsic Motivation as predictor to PCL shows *F*=18.140, *p*=0.000. Beta=0.498. Adjusted R^2=0.248.

Self-Regulation as predictor to PCL shows *F*=4.579, *p*=0.037, indicating a 3.7% chance that the null hypothesis is true. Adjusted R^2=0.060, Beta=0.277. This suggests that Self-Regulation only predict PCL with 6% of the variation.

Multiple regression of Curiosity and Intrinsic Motivation on PCL shows *F*=12.714, *p*=0.000. Adjusted R^2=0.295, Beta=0.313 (C) and 0.337 (I), respectively. This shows that together, Curiosity and Intrinsic motivation predict 29.5% of the variation in PCL. Due to the limited increase in prediction value from Single regression model to multiple regression, there is a chance that an increase sample size could better describe the prediction.

Since Curiosity and Intrinsic Motivation shows good potential towards PCL, it could be profitable to assess the subfactors of the concepts to better understand what affects PCL. Exploration was the most significant factor of the curiosity subscales, the other being absorption. Exploration shows *p*=0.000, Adjusted R^2=0.383, Beta=0.628, *t*=5.985, *F*=35.821. Absorption shows *p*=0.050, Adjusted R^2=0.051, Beta=0.261, *t*=2.002, *F*=4.009. Which, in a single regression sample assume that curiosity and absorption predict PCL with 38.3% and 5.1% of the variation, respectively.

Intrinsic motivation did not show a shared significance when approached with a multiple regression *p*=0.088. Interest did not show a significant *t*-value in single regression (*p*=0.112). Neither did Perceived Choice (*p*=0.230). However, Value showed a significant value, *p*=0.002, Adjusted R^2=0.147, Beta=0.403, *t*=3.264, *F*=10.656. As expected, Perceived Competence shows a significant prediction to Perceived Competence Learning (*p*=0.000) and is assumed to predict 39.9% of the variation in PCL.

On learning outcome. Intrinsic motivation predicts Learning Outcome with 30.7% of the variation (Adjusted R^2=0.307). *F*=25.792, *p*=0.000. *t*=-0.808. Beta=0.565.

Curiosity shows disappointing little relation to Learning Outcome with Adjusted R^2=-0.018, *F*=0.033, *p*=0.856. Suggesting that there is an 85.6% chance that the null hypothesis is true. Thus, curiosity did not seem to affect learning outcome. Based on a split file test to determine which test group benefited the most, the pre-test showed the most significant relation, with a *p*=0.053, which is not entirely significant if *p*<0.05, and Adjusted R^2=0.133.

The experiment group showed a significance value of p=0.205 and Adjusted R^2=0.035. The control group showed least relation with p=0.500 and Adjusted R^2=-0.041.

Compare Means

Upon examination of the difference between the test groups, the pre-test showed the highest Leaning Outcome (M=3.55, *N*=22), followed by the post-test experiment group (M=3.38, *N*=21), and lastly the post-test control group (M=3.21, *N*=14). This indicates that the students expected to have a larger Learning Outcome before class than how they experienced Learning Outcome after the class.

Curiosity. The pre-test showed the highest mean levels of Curiosity (Mean=4.07, *N*=22), followed by the post-test experiment group (M=3.82, *N*=21) and post-test control group (M=3.58, *N*=14).

Intrinsic motivation. Intrinsic Motivation scored highest with the experiment group (M=3.35, *N*=21), closely followed by the pre-test group (M=3.33, *N*=22). The control group scored the lowest (M=3.24, *N*=14).

Self-regulation. The control group scored highest on the self-regulation item (M=3.92, *N*=14), while the pre-test group (M=3.72, *N*=22) and experiment group (M=3.71, *N*=21) scored almost identical. These results may suggest that the students needed to employ more self-regulation in the control group as they were not intrinsically motivated nor curious enough to find the material interesting enough to a voluntarily approach the subject. However, the students of the control group also scored highest on Perceived Competence for Learning, suggesting that by employing self-regulation the students still believed they were able to master the course material.

Perceived Competence for Learning. As with self-regulation, the control group scored highest on Perceived Competence for Learning (M=4.38, *N*=14), followed by the pre-test group (M=4.36, *N*=22), and the experiment group (M=4.28, *N*=21).

ANOVA

As there are more than two conditions tested, specifically the three test groups, the ANOVA test, or analysis of variance, was selected to further explain the relations of the variables in addition to the t-test. However, the findings between groups were not significant when assessed through ANOVA. These findings suggest that the study is in need of a greater sample size, and with the current population is unable to accurately prove a relation between any of the factors in relation to the other groups. In other words, this study is unable to reject the null hypothesis.

Repeated Measures ANOVA

The repeated measures ANOVA indicated a large variance due to manipulation in contrast to random factors, consequently yielding large *F*-values, however, due to sphericity and loss of power, this study is unable to conclude that the observed results have a significant effect on the population. However, to illustrate, the *F*-ratios will be presented along with the Type III Sum of Squares (SS3). Between Curiosity and Intrinsic Motivation, the *F*-ratio is 27.400, and the SS3=14.617; between Intrinsic Motivation and Self-Regulation, *F*=18.868, and SS3=12.375; between Self-Regulation and Perceived Competence for Learning, *F*=11.141, and the SS3=16.975; and lastly between Perceived Competence for Learning and Learning Outcome, *F*=17.308, and SS3=50.481.

Mauchly's test of sphericity. Mauchly's Test of Sphericity depicts a significant result (*p*=0.000) when assessing Curiosity, Learning Outcome, Intrinsic Motivation, Self-Regulation and PCL, indicating that there are differences between the variances of difference, resulting in that the condition of sphericity is not met. Consequently, the sphericity creates a loss of power and the validity of the *F*-ratios is decreased. Again, this study will stress the importance of a larger sample size for future studies.

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
TestGroups	,248	73,170	9	,000	,625	,682	,250

Table 6: Mauchly's Test of Sphericity between Curiosity, Intrinsic Motivation, Self-Regulation, Learning Outcome, and Perceived Competence for Learning.

Bonferroni method. Using the Bonferroni method to examine the within-subjects relation with more power and control over Type 1 error rate (Field, 2014), Curiosity showed a significant relationship with Intrinsic Motivation & Perceived Competence for Learning. Intrinsic Motivation displayed a significant relationship with Curiosity, Self-Regulation, & Perceived Competence for Learning. Self-Regulation with Intrinsic Motivation & Perceived Competence for Learning, and Perceived Competence for Learning with all; Curiosity,

Intrinsic Motivation, Self-Regulation, & Learning Outcome. Learning Outcome, however, only showed a significant relationship with Perceived Competence for Learning.

Neither the Greenhouse-Geisser or the Huynh-Feldt estimate depicted a sphericity below the lower-bound estimate of 0.25.

Post hoc. The post hoc test, using the Games-Howell procedure as the sphericity could not be assumed, did not show any significant values. However, as Field (2014) suggest, sphericity causes some issues for post hoc tests, and the Bonferroni method remains the most robust in terms of controlling the alpha levels regardless of the manipulation.

To summarize, if the sphericity is assumed, F=13.241, p=0.000. This means that there was a significant difference from the variables. However, because Mauchly's test of sphericity showed a significant value, the result is a violation of sphericity and decreasing the validity of the F-ratio.

Mauchly's test indicated that the assumption of sphericity had been violated, x2(5)=11.41, p=0.047, therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity (ε=0.67). The results show that the tested variables; curiosity, intrinsic motivation, self-regulation, perceived competence for learning, and learning outcome was not significantly affected by the variation of test groups, F(2, 13.98)=3.79, p=0.048, ω=0.24.

MANOVA

As the violations of sphericity affects the accuracy of the F-ratio, MANOVA was applied. Yet, the MANOVA effect of the test groups were not significant, Pillai's Trace's p=0.655; Wilks's Lambda's p=0.652; Hotelling's Trace's p=0.649; and Roy's Largest Root's p=0.218. Thus, this study cannot report a significant variance between the test groups.

Discussion

"Perhaps no single phenomenon reflects the positive potential of human nature as much as intrinsic motivation" (Ryan & Deci, 2000b). There seems to be little doubt from research that intrinsic motivation further learning. However, how the curiosity element or intrinsic motivation affect learning outcomes is less apparent. In the example with the photographer, the link between curiosity and motivation is noticeable. The issue arrives when trying to understand how the motivation is caused by curiosity and explorative behavior results in learning. The simplest way to display the correlation is to address explorative behavior as a method of information-seeking. For instance, when the foreign environment is explored, new information is absorbed, consequently the photographer, maybe unintentionally or unknowingly, learns about the environment and the subject of his photography. This

example does not separate between extrinsic and intrinsic motivation, as the motivational orientation of an action is elusive and situational. Nevertheless, exploration is generally intrinsically motivated as extrinsic motivation tend to be goal-oriented and in the example of the photographer, the reward is more arbitrary than the enjoyment of his hobby.

Intrinsic Motivation & Curiosity

Ryan & Deci (2017; cited by Domenico & Ryan, 2017) have discovered during four decades of field research through the framework of self-determination theory that intrinsic motivation predicts enhanced learning, performance, creativity, optimal development and psychological wellness (Deci & Ryan, 1985; 2000; 2002; 2008; Ryan & Deci, 2000a; 2000b). In contrast to this study's approach, Ryan & Deci (2017; cited by Domenico & Ryan, 2017) argue that curiosity is an affective state – similar to interest and fun – and can be used to measure intrinsic motivation. This study, on the other hand, approach curiosity from the theoretical viewpoint of Loewenstein (1994), and Kashdan and colleagues' (2004) subscale definition – namely exploration and absorption. Though, neither of the studies dismiss the effect of curiosity on intrinsic motivation, the latter two doesn't include it as a part of intrinsic motivation. Admittedly, it is difficult to argue against more than four decades of research, which indicates that it is possible for curiosity to be accepted as a part of intrinsic motivation in the near future. Until then, this paper will address both subjects individually and collaboratively to gather a holistic perspective on both curiosity and intrinsic motivation.

Intrinsic motivation results. Intrinsic motivation was found to correlate with a variety of factors. Among them, several facets of intrinsic motivation portray significant relations with each other. Interest, for example, displayed a significant correlation with perceived choice and value, but not perceived competence, which are all facets of intrinsic motivation. While the strong relationship with a majority of the facets could theoretically strengthen the validity of the Intrinsic Motivation Inventory, it is strange that perceived competence and perceived choice did not correlate as they both were theorized to be predictors of self-report and behavioral measures of intrinsic motivation (Deci et al., 1994). Perceived competence did not correlate with any other facet of intrinsic motivation, yet was significantly correlated with intrinsic motivation, which indeed raise questions of its role in understanding intrinsic motivation, especially since the SDT heavily emphasize the importance of competence and intrinsic motivation in learning (Niemiec & Ryan, 2009).

As mentioned, the facets of intrinsic motivation did correlate with other facets besides intrinsic motivation. Interest was found to correlate with both curiosity facets; exploration and

absorption, which supports this study's hypothesis. Deci and colleagues (1994) states that the interest subscale of the Intrinsic Motivation Inventory is considered the self-report measure of intrinsic motivation, indicating that intrinsic motivation and curiosity is correlated. This is further supported through other facets being correlated, specifically, perceived competence was found to correlate with both exploration and absorption, while perceived choice correlated with absorption and value correlated with exploration. To conclude, intrinsic motivation and curiosity measured without facets did correlate. Furthermore, the correlation has a solid foundation in that all the facets of intrinsic motivation correlated with the facets of curiosity. Limiting the correlations to the test groups, however, only the pre-test group and experiment illustrated a relationship between intrinsic motivation and curiosity, while the control group did not. While these results will be explored in depth later, it is worth to mention that the sample size became very small when split into groups and that the control group, which was tested on the second day, only consisted of 14 participants, making it difficult to address the correlations split by groups.

Intrinsic or Extrinsic?

It is by no means an easy task to apply curiosity to the academic setting, especially since intrinsic motivation is often a necessity for a successful learning outcome if curiosity is to have any affect. However, in school, extrinsic motivations is often applied due to the simplicity of a reward-based system. A study by Deci, Koestner & Ryan (1999) presents that people experience less interest and decreases spontaneous participation in activities in which they were intrinsically motivated after receiving rewards for engaging in those activities. These findings present a problem for educators who wish to employ curiosity or intrinsic motivation into education. Some measure of achievement will most likely always be part of the educational system. Thus, reward and extrinsic motivation are unavoidable.

Alternatively, through the classical frameworks of behaviorism, receiving rewards for intrinsically motivated tasks, such as reading upon a school subject on own accord due to interest or another intrinsic motivation, may reinforced such behaviors through operant conditioning. Theoretically, rewards can in such a way positively reinforce intrinsic motivation and in turn curiosity and its exploratory behavior. As Watson & Rayner's famous study of little Albert (1920) stipulate, the reinforced behavior may just as easily disappear should the student receive an unsatisfactory grade.

Another possibility is that the student will transform the formerly intrinsic motivation into extrinsic motivation, as the study by Deci and colleagues (1999) indicate. Then the

student accepts his formerly intrinsically motivated approach to be effective in terms of learning and employ this tactic to receive good grades.

However, though good grades and other academic rewards will motivate students extrinsically, and students may approach a subject with intention to perform well at a test and forego exploring the subject and learn topic outside the syllabus. Arguably, intrinsic motivation could also have a positive outcome in academic settings, not necessarily to receive good grades, but to learn subjects at a broader or deeper perspective (Marton & Säljö, 1976; cited by Floyd, Harrington, & Santiago, 2009).

Intrinsic motivation and learning results. As hypothesized, intrinsic motivation correlated significantly with both learning outcome and perceived competence for learning. Addressing the facets of intrinsic motivation, interest, value and perceived choice correlated with learning outcome, while perceived competence did not. However, perceived competence, along with value, displayed a significant relationship with perceived competence for learning. As mentioned, perceived competence was expected to correlate with perceived competence for learning due to the similarities of the terms. These results indicate that interest and perceived choice enhances an individual's learning outcome, while value also contribute to increasing the person's perceived mastery of the subject.

Though intrinsic motivation may seem to positively influence learning, it is by no means easy to manipulate into becoming an essential part of the academic context.

Difficulties of Implicating Intrinsic Motivation to Education

Motivation have played a part in education for a long time, even from a scientific perspective. Behaviorists applied motivation to learning, but as basic drives such as hunger and thirst (Hull, 1943). To be motivated, the idea was to evoke a state of deprivation, such as being hungry. However, humans, as well as other animals, are motivated to acquire information without primary drives. For example, rats have displayed "patrolling" behavior, and will often explore areas not associated with finding food, meaning that this behavior is not learnt (Birke & Archer, 1983; cited by Pluck & Johnson, 2011). This behavior presents a problem for behaviorist explanations of motivation and subsequent learning.

If we accept the hypothesis that intrinsic motivation positively affects learning, a primary objective would be to apply this to the academic setting. In regards of boosting intrinsic motivation, studies have found that positive feedback (Fisher, 1978; Ryan, 1982) and choice (Zuckerman, Porac, Lathin, Smith, & Deci, 1978) enhances intrinsic motivation. On the contrary, negative feedback (Deci & Cascio, 1972; Vallerand & Reid, 1984), deadlines

(Amabile, DeJong, & Lepper, 1976), and other external encumbrance (Lepper & Greene, 1975) negatively affected and diminished intrinsic motivation. Reinforcing intrinsic motivation with increased positive feedback and choice could have other benefits as well. Choice, as beneficial to learning is further supported by this study, which found correlations between choice and interest in both post-test groups, as well as a correlation with learning outcome in the control group. Eliminating unnecessary burdens to intrinsic motivations should also be a primary objective in applying intrinsic motivation to the classroom. However, some factors are near impossible to remove, specifically deadlines, which is present in many aspects of the adult life as well. Due to deadlines' important role in school in regards of preparing the student for adulthood, and other trials, it is debatable if deadlines should continue as a part of a student's academic career, despite the possibility of it hindering intrinsic motivation.

Interest

And curiosity. Curiosity and interest have been found as intertwining concepts in many studies (Bowler, 2010; Silva, 2008), though curiosity have been attributed to cognition, whereas interest to emotion. Both terms are related to motivation, especially in regards of school-based information tasks. In many complex problems, investing a great amount of effort is needed to achieve a higher understanding of the subject (Blumenfeld et al., 1991). Hidi (1990) argues that interest is key in determining how we select and persist in processing certain information in preference to others, which corresponds with Bowler's statement that interesting research projects in school is characterized by the students' choice and control of their work. This idea was also part of the foundation of the current study, that choice mixed with curiosity would influence interest, and in turn learning.

Bowler (2010) argue that interest-based activities involve attention, concentration and persistence, which she asserts as three attributes of complex learning. This approach, while similar to the concept of deep learning, seems to include self-regulation to a larger degree than the theory of Marton & Säljö (1976; cited by Floyd et al., 2009).

And motivation. Gross (1998) discovered that "imposed query", in which the query is formulated by one person, but answered by another, can be difficult to answer due to the difficulties that arise with interpretation of meaning and relevance. To answer, a collaboration between cognition and motivation is needed. If the query is asked by a teacher to a student, the query might not be perceived as relevant if it is not interesting. The query then receives little attention as the intermediary is not motivated enough to explore it. This relationship

between interest and motivation is of particular relevance for this study as it argues the need for a motivational nudge in addition to the query, if the query is not perceived as interesting. While this study's procedure left the students to self-regulate on their own, hoping that curiosity alone could evoke interest and motivation to achieve some learning outcome, Gross's findings suggest that interest would help to sustain effort, promote deeper processing, and increase understanding.

In Bowler's study (2010) participants were too allowed to freely explore, but unlike this study were allowed to choose a topic themselves from a much broader framework. In her study, all participants found a topic of interest, and was motivated to explore their topics. Though the purpose of her study and this study is largely different, her approach would perhaps serve better to achieve a better estimate of how curiosity may affect learning. However, as Bowler also points out, most academic assignments are bound by restrictions, and thus the study would not provide an accurate correlation betwixt curiosity and learning in an academic setting.

And self-regulation. Intriguingly, Bowler (2010) found that curiosity could be split in two types, one related to the topic and the other to the process. She argues that success in the process might have switched the interest from the topic to the process. Bowler distributes this switch as an act of self-regulation. She discovered that individuals were able to limit their own exploration after their current needs and argues that this self-regulation is evidence of metacognition. If the participants were to have limitless exploration of the information environment, it would sate their curiosity, but hinder progress and completion of their task on time. These findings suggest that though curiosity is beneficial for the overall gathering of information, self-regulation is needed to sort out what is necessary and for when to stop, even if the need for curiosity isn't entirely sated.

Types of interest. Hidi (1990) differentiates between two types of interest: individual interest and situational interest. Individual interest refers to personal preference and has long-lasting effects on knowledge and values. Situational interest, on the other hand, is often evoked by environmental factors and usually only have short-term effects. As interest in this study is positively correlated with learning outcome, there is no distinction between subcategorizations of interest. However, this could prove sagacious to research in future studies as it might help determine if the outcome likely to be remembered in an academic setting or not.

Peterson (1999) argued that dedicated pursuit of one's interest increases personality development through exposure to novel ideas and challenges, thus promoting learning, growth, and meaning in life. Pursuing interest can certainly have positive outcome, especially in relations to the role interest plays in intrinsic motivation. The connection between interest and intrinsic motivation is further supported by the correlational findings of this study. Furthermore, interest was found to correlate with curiosity, learning outcome, choice and value, suggesting that interest plays a vital role in our understanding of intrinsic motivation and that it may prove useful in the educational context.

Flow

Flow is conceptually similar to the SDT's intrinsic motivation (Deci & Ryan, 1985; 2000), as flow refers to experiential states of total absorption, optimal challenge, and non-self-conscious enjoyment of an activity (Csikszentmihalyi, 1990; cited by Domenico & Ryan, 2017). Absorption is also a key subscale of measuring curiosity, making flow relevant to this study.

Similar to intrinsic motivation, flow is experienced as satisfying enough that the activity itself is autotelic. Further similarities can be found with the SDT as flow theory emphasize optimal challenge and competence satisfaction associated with intrinsic motivation.

Cognitive Evaluation Theory

Cognitive evaluation theory (CET) proposes that underlying intrinsic motivation are the inherent psychological needs for competence and self-determination. The effects on intrinsic motivation of external events such as rewards, evaluation, deadlines, are a function of how these events affect a person's perceptions of competence and self-determination. Events that decrease perceived self-determination, i.e. which leads to an external locus of causality, will diminish intrinsic motivation. Consequently, events that increase self-determination, i.e. which leads to an internal locus of causality, will enhance intrinsic motivation (Deci, Koestner, & Ryan, 2001).

The CET proposes that external events have two aspects. The informational aspect conveys self-determined competence and thus enhances intrinsic motivation. On the other hand, the controlling aspect elicit an external perceived locus of causality and thus undermines intrinsic motivation (Deci et al., 2001).

Perceived Competence and Exploration

As explained, perceived competence in regards of the SDT is considered as feeling effective, and the sense of growing mastery in activities that are optimally challenging (Domenico & Ryan, 2017). Though there are discrepancies between theories in regards of exploration, whether it is to be considered a product of curiosity or intrinsic motivation, there are many findings that supports the findings of this study; a correlation between competence and exploration (Domenico & Ryan, 2017; Lazarides, Rohowski, Ohlemann, & Ittel, 2015).

A study by Lazarides and colleagues (2015) found that competence and relatedness in class was significantly positively related to the students' intrinsic motivation and self-exploration. Intrinsic motivation significantly correlated positively with self- and environment exploration, but also achievement. The significant correlation with achievement is intriguing since many studies have found a relation between intrinsic motivation and competence (Domenico & Ryan, 2017; Schüler et al., 2010), or perceived competence which is supported by the current study. However, few studies can confirm an actual link between intrinsic motivation and achievement. In turn, these results could strengthen the validity of perceived competence and the SDT. Furthermore, it provides support for the employment of competence and intrinsic motivation theories in educational context.

Perceived competence findings. Perceived competence displayed a significant correlation with both curiosity and intrinsic. Regarding curiosity, perceived competence also correlated with both facets, which emphasize that both exploration and absorption of a subject may influence an individual's perception of ability regarding the subject. However, as this is purely correlational findings, and does not offer causality, an equally important possibility is that one's perception of mastery may result in increased incentive to explore and become absorbed in a subject. This is an interesting perspective due to the implications of actionable behavior, or simply put whether a person engages in an activity or not. For instance, would the photographer from the earlier example engage in exploring the nature if he did not believe in his ability to successfully shoot a good picture? Now, this example may seem to border on the extrinsic aspect of motivation, which brings up the significant correlation between perceived competence and intrinsic motivation. It is possible, and would not be surprising, that perceived competence could correlated with extrinsic motivation as well. The controlled facet of self-regulation has been linked with extrinsic motivation. This study found a link between controlled regulation and perceived competence for learning, but not perceived competence. These results suggest that though the controlled aspect of self-regulation may not

explain feelings of capability, it may assist in learning when extrinsically motivated. To illustrate, the student may not learn a skill or master an activity for an extrinsic reward, but the student may be willing to learn, or feel capable of learning, in face of an extrinsic reward.

Perceived competence correlated significantly with perceived competence for learning, as hypothesized. This is thought to be due to the similarities of the terms and survey questions. Perceived competence for learning on the other hand, shows some rather interesting and unexpected correlations, namely with controlled regulation. It was hypothesized that perceived competence for learning would be significantly with autonomous regulation, which according to Ryan & Deci (2000a) is connected to intrinsic motivation. These results may suggest – similar to the findings of perceived competence – that the perceived ability to master or learn a subject may depend on external motivations, or that the perception of ability may influence the employment of controlled regulation of extrinsic motivation. Perceived competence for learning also displayed a relationship with self-regulation, indicating that perceived competence for learning may be affected by both intrinsically and extrinsically focused regulation.

Self-Regulation

Bandura proposed in 1977 a social cognitive theory which explained how learners acquire competencies, skills, dispositions, beliefs, and self-regulation. It has since been an important foundation to understanding learning and development. Zimmerman (2000) honed the theory and explained that self-regulation of learning refers to students' self-generated thoughts, feelings, and actions that are designed to influence learning of knowledge and skills. Zimmerman (2000) further argue that individuals with high levels of self-regulation are cognitively, motivationally, and behaviorally active participants of their own learning process.

Some studies suggest that when individuals engage in self-regulatory behaviors such as goal-setting, self-monitoring, self-evaluation, and self-reflection, they achieve high levels of personal, academic or professional results in a variety of domains (Clark & Zimmerman, 2014).

Autonomous and controlled regulation. Edmunds, Ntoumanis, and Duda (2006) discovered that competence and autonomy significantly and positively influenced self-determined regulation, which supports the hypothesis of the current study, however, as the results of this study indicate, it was unable to detect any significant correlation between perceived competence and autonomous regulation. However, autonomous regulation was significantly correlated with learning outcome. While controlled regulation did not correlated

with learning outcome, it did correlate with perceived competence for learning. Consequently, the controlled and autonomous regulation may affect different aspects on how an individual learn. However, these results also somewhat argue against the reflection of the SDT, as Ryan & Deci (2000a) generally argue that the autonomous regulation align with intrinsic motivation, while the controlled regulation coordinate with extrinsic motivation.

Autonomous regulation results. Though not all groups significantly correlated with self-regulation factors, learning outcome and perceived competence for learning did without splitting into test groups. Furthermore, autonomous regulation was found to significantly correlate with the value facet of intrinsic motivation. Value is important in selection of what activity or material an individual decides to engage in (Rossing & Long, 1981), and it should not come as a surprise that autonomous regulation – which is theorized to be important to intrinsic motivation (Ryan & Deci, 2000a) – plays a role in regulation what subject the individual engages in. However, as this study did not find a significant correlation between autonomous regulation and intrinsic motivation it is difficult to support Ryan & Deci's (2000a) theory.

An interesting finding is that self-regulation does not correlate with learning outcome in the control and experiment group, yet does so in the pre-test group. However, intrinsic motivation did not correlate with learning outcome in the pre-test group, but did depict a significant correlation in both the control group and experiment group. While cautious of the low sample size and reliability that ensues, this would be an interesting find, indicating that a shift between regulation and motivation to achieve learning outcome. Upon examination of the facets, only autonomous regulation was found to correlate with learning outcome and does so in the pre-test and control group. These results may indicate that an individual is not needed to employ both self-regulatory actions and motivational behavior to ensure a positive learning outcome.

Self-Regulation in Education

Agina (2012) argue that though students have freedom to learn what and whenever they want in school, they are still under the influence of the teacher through human's external regulation. This interaction and social intervention is perceived as a hinder to children's cognitive development, imagination, and creative thinking (Agina, 2012). This is a debate of educational learning processes versus children's natural development process. The hope of the current study is, however, to apply the natural development into the academic setting. What Agina's study (2012) means for the current study is that the effect of curiosity and intrinsic

motivation on learning would differentiate significantly outside the school environment, and that possibly all motivations found in the educational setting stems from an externally regulated source, and that intrinsic motivation is rare to find in the academic setting.

Conversely, many studies argue that schools are complex in terms of self-regulation and would be very different from a controlled laboratory setting (Pintrich & De Groot, 1990; Pintrich, Roeser, & De Groot, 1994; Schunk, 2005). An example of this complexity can be brought to light through research by Newman & Schwager (1992) on help seeking. Help seeking from others, typically teachers or parents, seems like a natural response in school and other learning environments. Historically, wisdom from others were often employed to learn concepts and skills. However, due to the difference in frequency, amount, and type of help seeking, Agina (2012) argue that there exists a complex interaction between social and motivational factors.

Agina (2012) examined how children regulated their own process of learning and how they engage in learning behaviors on their own, without human external regulation. Instead, Agina employed a nonhuman external regulation with a computer game to facilitate learning. While the study found that children are capable of learning on their own accord, the results that indicate that the children are motivated by knowing that they can regulate their own process of learning is to some extent undermined by the reward session part of the experimental design which offered the child a piece of candy. Though there is no question of the effectiveness of external motivation (Ryan & Deci, 2000a), it is not a pragmatic solution to the educational system to learn with the hope of receiving external rewards. Furthermore, the findings of Deci and colleagues (1999) suggests that when the participants cease to receive external motivation, they stop doing intrinsic motivational tasks, which in Agina's study (2012) may hinder the natural learning process or disrupt the educational learning process.

Epistemic Curiosity

Epistemic curiosity is an emotional-motivational state and reflects the desire for new information that in turn motivates exploratory behavior and knowledge acquisition (Berlyne, 1954). It is a complex term due to its emotional nature and can be perceived as both positive, in which the individual experience feelings of interest associated with the anticipation of learning something new, and negative as unpleasant emotions of uncertainties due to knowledge deficiency (Litman & Jimmerson, 2004; cited by Litman et al., 2005).

Curiosity have often been split between feelings of interest, meaning the desire to know for its own sake, and feelings of deprivation, meaning the want to know stems from the frustration of not knowing. This continuation of early theories of curiosity proposed by Berlyne (1954; 1960) is important to emphasize because it renders feelings of curiosity and subsequent exploratory behavior as pleasurable (Kashdan, et al., 2004; Kashdan et al., 2009; Park, Peterson & Seligman, 2004; Naylor, 1981). However, the assumption that curiosity is pleasurable ignores the possibility that individuals seek information to resolve their confusion and tension (Loewenstein, 1994). Supporting the contradiction, there are findings which indicate that people are willing to act upon curiosity even when there are no apparent reward, yet will lead to pain or punishment. Sating the need for curiosity is a strong, basic human motive (Hsee & Ruan, 2016; Reiss, 2004). Curiosity remains a broad term, and these ambivalent perspectives of viewing curiosity as pleasure of discovery or the reduction of information gaps does seem to correlate when researched as distinct factors (Litman, Crowson, & Kolinski, 2010). To put the different aspects in perspective, enthusiastically exploring the world attempting to learn about the environment can be perceived as qualitatively different from feeling tense and being unable to sleep until an answer is obtained. There are also more to curiosity than these two facets reveal.

In many scenarios, the individual facing a novel event will have the choice of being curious or not. This choice entails whether the person perceives themselves as able to cope with the negative affiliation of curiosity, typically the stress that arises when exploring novel, complex, uncertain or unfamiliar territory (Silva, 2005). Furthermore, willingness to take social, financial, physical or legal risks to experience the novelty is also taken into consideration (Zuckerman, 1979).

Intriguingly, in Zuckerman's 40-years of research (1994; cited by Kashdan et al., 2018) regarding thrill-seeking and being adventurous, which share similarities with curiosity; he found that stress isn't avoided, rather sought to be amplified.

Information Gap & Loewenstein

Loewenstein (1994) proposed a hypothesis called "information-gap" which states that curiosity arises when individuals experience a discrepancy between current knowledge and what they want to know. This lack of equilibrium can be experienced as aversive, however, satisfying curiosity is gratifying, thus people freely seek curiosity.

There are relations between Loewenstein's information-gap theory of curiosity and SDT, especially as he described curiosity as an intrinsically motivated desire for specific

information (1994; Domenico & Ryan, 2017). Other connections are that both curiosity and intrinsic motivation are processes that employs self-directed learning. Loewenstein's theory does not include autonomy, however what is regarded as an information-gap suits SDT's notion of competence. To illustrate, an individual's need for competence, or intrinsically motivated activities toward novel stimuli and optimal challenges, can be seen as repeated seeking and reducing information-gaps in knowledge.

However, the theories do not align completely, as Loewenstein argue that curiosity is consummatory, a drive reduction process, or the closure of information-gaps (1994). This creates an issue with the continual concept of intrinsic motivation. White (1959) and Deci & Ryan (1985) argued that curiosity for certain objects or locations may be sated through exploration, the tendency to explore itself is not satiated. To reconcile the SDT's organismic account of intrinsic motivation and Loewenstein's drive reduction account of curiosity seeking Domenico & Ryan (2017) propose that curiosity is a more limited phenomenon subsumed by intrinsically motivated exploration.

Domenico & Deci (2017) argues that intrinsic motivation is not an automatic expression, but a lifelong psychological growth dependent on ambient supports for basic psychological needs proposed by the SDT, especially competence and autonomy, or in other words feeling effective and acting volitional.

Applying Curiosity in Education

Curiosity in terms of information gap is directly applied to education more frequently than one may expect, specifically when learning a second language (Pluck & Johnson, 2011). In many language-learning tasks, the learner is presented with a text featuring a gap and asked to fill in the missing word. This refers to a group of tasks called "information gap" tasks which are frequently used in teaching a second language (Ur, 1996). One example of such a task could be that one student is tasked to verbally describe an image that the other cannot see. This task fits Loewenstein's information gap theory very well as the students' knowledge of the image would gradually increase, thus decreasing the gap and increasing the curiosity.

Detriments of Curiosity

Curiosity is not necessarily all positive experience, and can, if unregulated, be dangerous, especially for children. For instance, a child is naturally curious, and part of why many baby-proofs their house is that the infant's curiosity is liable to cause the child harm. A typical example can be fire, or heat-generating objects like a hair-straightener. There are also cases where curiosity can be negative for adults as well. These actions can range from spying

and stalking to severe behavior disorders such as voyeurism, drug and alcohol abuse, early sexual experimentation, and arson (Green, 1990; Cullari & Mikus, 1990; Kolko & Kazdin, 1989).

A study by Bowler (2010) found that curiosity among students could be experienced as both positive and negative. Curiosity was a positive motivator engaging the students in exploration and discovery, however was also viewed by some as a source of frustration due to the imposed nature of the information task. Bowler argues that though many educators expect curiosity to be all positive, curiosity is often juxtaposed next to negative terms such as worry, frustration, overwhelming, and aggravated.

Idioms, such as "curiosity killed the cat" or "burning with curiosity" reflects the undesired nature which curiosity can contain, but this is often an unfair assumption, as curiosity can be instrumental to learning.

Curiosity and Learning

Gentry and colleagues (2002) tested the information gap measurements on students from USA, China, and Canada, and found that students with large information gaps is more liable to perform badly in school than those with less information gaps. The concept revolves around that students feel that the information gap is small, and they can achieve closure, the curiosity will subsequently be high. With large gaps, curiosity will be low as the students don't sense a possibility of closure at hand.

In a more recent study of the closeness to closure supports the previous findings (Litman, Hutchins, & Russon, 2005). In this experiment, students felt more tension and curiosity to find the answer to the question when they had a feeling of knowing. The applicability of these findings in education can be very useful as Berlyne (1954) found that individuals remember better the answer to questions the participants had rated as more puzzling.

Curiosity in school children. Though there are still debate whether curiosity should be included in SDT's conception of intrinsic motivation, there is no avoiding the benefit of curiosity acting independently. Curiosity is traditionally viewed in psychology and neuroscience through how it evokes underlying mechanisms such as novelty, surprise, conceptual conflict, uncertainty, and the anticipation of new knowledge (Jirout & Klahr, 2012). Knowledge seeking experiences can create positive impact on students' belief about their competence of mastery in regards of scientific processes, consequently promoting a greater breadth and depth of information exploration (Wu & Miao, 2013). In today's

classrooms, learning in small groups plays an important role. Therefore, it is critical to understand curiosity at an interpersonal level and how it is shaped by the social environment. In this study, all participants worked independently in silence, yet cooperation was possible. Though this was the case in this study, it is expected to vary much from class to class, and between teachers' authority in the classroom. Nevertheless, the possibility of cultural difference should also be examined when assessing curiosity in cooperation in an academic setting.

Embodied Conversational Agents (ECAs) display a unique capacity in supporting learning and collaborative skills in children (Cassell et al., 2000). Sinha and colleagues (2017) argue that by knowing how social factors influence curiosity, researchers can design ECAs and other learning technologies to support curiosity-driven learning before children are able to support each other naturally. Sinha et al. (2017) created a framework to address this goal, and to create a theoretical foundation to inform the design of learning technologies, and to create a virtual peer that employ pedagogical strategies to elicit and maintain curiosity in social contexts.

Intrinsic Motivation in School

Supporting this study's hypothesis, Taylor and colleagues (2014) and Froiland & Worrell (2016) points to intrinsic motivation as one the most important forms of motivation in school achievement, and that achievement can positively predict intrinsic motivation. Furthermore, Taylor et al. (2014) found that academic motivation can negatively predict external regulation, which supports Deci & Ryan's (2000a) theory of self-determination, that satisfaction of competence leads to the development of more autonomous forms of motivation.

Applying the SDT to the academic setting reveals that students are driven by externally or internally regulated forms of learning behaviors that agree with different forms of motivation (Ryan & Deci, 2002). Intrinsic motivation most often occurs when the students are interested in learning and enjoy their activity. During this process, their learning behavior is driven by internalized regulation. Deci, Vallerand, Pelletier, & Ryan (1991) discovered that situational factors in learning environments that positively affect intrinsic motivation are those who satisfy the individuals' internal needs for autonomy, competence and relatedness.

Teachers' role. Learning, and intrinsic motivation, is by no means the students' responsibility alone. Teachers play an important role as educators for students, and their teaching strategies provide structures for the students. Studies have shown that to experience

competence-support in educational settings, the students rely on constructive and informative feedback, and student-perceived informative feedback is positively correlated with intrinsic motivation (Noels, Clément, & Pelletier, 1999). Furthermore, Skinner & Belmont (1993) found that student-perceived classroom structure has been shown to increase effort in learning.

Lazarides et al. (2015) found that classrooms that promotes the SDT components competence, autonomy and relatedness facilitates intrinsic motivation and self-exploration in the students. Furthermore, they found that teachers facilitate intrinsic motivation among their students as well as career exploration. The teacher creates this learning environment through enhancing the students' feeling of autonomy, by providing them with competence feedback and by making them feel emotionally involved. Contradicting their hypothesis, they found however no significant correlation between student-perceived support for autonomy and competence with students' achievement.

Bowler (2010) argues that intellectual curiosity is the lifeblood of learning, thus one of the goals of any educator should be to promote this intrinsic motivation to learn. She further argues that classrooms, information systems, and teaching methods are designed to stir curiosity. In many ways, this may be the case, particularly among young students, as classrooms often are filled with interesting objects, drawings, or maps. This, however, is not that often the case for older students, which brings the question of whether older individuals don't benefit equally from curiosity. It may also be because learning among older students is more specialized, and curious objects serve more as a distraction. Bowler, points out that the students' association with curiosity as pain, not pleasure, is paradoxical due to promotion of curiosity in their earlier educational career. One reason may simply be misplaced resent towards being forced to attend school as a child.

Teaching Strategies

Two complex teaching methods that involves evoking student curiosity is the task-based learning (TBL) and problem-based learning (PBL). These methods have been popular in teaching second language (Willis, 1990; cited by Pluck & Johnson, 2011). TBL utilize the use of communicative tasks to aid language learning by presenting a situation which the student must communicate to achieve a task. For instance, a student learning Spanish as a second language may be tasked to give directions to the cafeteria to a fellow student as part of a role-play. TBL stress the importance of motivation in regards of enhancing learning by recognizing the desire to communicate.

PBL facilitates the idea of TBL, takes it a step further and gives the students a problem to solve, often based on real world difficulties, and with several potential solutions, or maybe no final solution exists. The core of PBL is the freedom of choice, and the learners may approach any relevant direction, whereas TBL is more restricted and the solution may be more apparent. In both learning strategies the students' motivation to learn is evoked by their curiosity by providing a challenge (Pluck & Johnson, 2011).

A practical example of the necessity of curiosity in education could be the case of medical students. Richardson (1986; cited by Pluck & Johnson, 2011) argue that it is important to maintain curiosity through the education, otherwise students may only want to learn what is necessary to gain qualifications (Mann, 1999). However, as times change, and the medical practice along with it, it is important to update medical professionals' knowledge, hence curiosity is important after the education is complete as well. Kedge & Appleby (2010) observed a similar situation in nurse training, where the need to promote curiosity is correlated with life-long learning. Since the medical practice is largely based on problem-solving, Pluck & Johnson (2011) argue that curiosity plays a large role in "deep" learning and intrinsic motivation in students.

The medical practice is a good example of applied problem-solving, because the medical professionals are often confronted with an unknown problem. The unknown factor can be presented as an information gap, which theoretically should be relatively small compared to that of a nonprofessional due to the educational relevance. The point is that Loewenstein's information gap theory of curiosity and the ensuing intrinsic motivation could support the concept of PBL.

Educating in the form of presenting problems or puzzles may mirror the daily lives of some medical professionals, thus PBL could prepare the student for what to expect. Yoo, Park, & Lee (2010; cited by Pluck & Johnson, 2011) argue that PBL is related to improved clinical decision making and motivation compared to traditional teaching methods. A related learning strategy is Case Based Learning (CBL) which is similar to PBL, but the teacher plays a more active role to prevent dwelling on issues. Srinivasan et al. (2007) found that medical students and trainers preferred CBL over PBL structured workshops. Both CBL and PBL can be regarded as enquiry-based learning (Brew, 2003), and Pluck & Johnson (2011) argue that the strategies are successful due to their ability to motivate students and elicit curiosity. Jurow (2005) found that simulating real-world projects can aid the student in identifying learning

goals and can evoke increased motivation and learning, which suggest that CBL could have more benefits than initially suggested.

Pluck & Johnson (2011) assert that the information gap theory and enquiry-based learning could stimulate curiosity at any higher level educational context simply by withholding information succeeded by students attempting to obtain it. However, since curiosity piques when the information gaps are small, it is important to assess the students' knowledge as presenting problems that require a vast amount of new learning would result in the information gap to be too large to have a significant value to curiosity and learning. Essentially, this means that enquiry-based learning cannot completely replace traditional learning, but complement it. Ginsberg (2010) proposes an alternative, where the teacher will monitor the students' information gaps to regulate how much information is needed and possible to introduce without overwhelming the students.

Providing feedback may also increase curiosity (Pluck & Johnson, 2011) as it allows students to identify gaps in their knowledge. As humans tend to overestimate their own knowledge, there is a possibility that students fail to become curious to a subject because they believe they are knowledgeable regarding the topic (Loewenstein, 1994). However, Loewenstein (1994) proposed that by asking individuals to guess information and by providing feedback, curiosity is significantly increased towards the unknown subject.

As mentioned, this method was partially employed in this study's experimental design where the teacher explained the foundation of a topic – the interwar period – but tasked the students to consider the significance of cultural radicalism that blossomed during this period. This was the control group, and the teacher's own teaching style, meaning that though there are some differences between the control group's teaching style and enquiry-based learning, there are certainly links with information gap learning. As a consequence of the teacher's already curiosity-based learning approach, there may not be a large difference between the control group's curiosity and the experiment group's curiosity.

Learning

Deep and surface learning. Marton & Säljö (1976; cited by Floyd et al., 2009) coined the term "deep learning" which implies learning in form of higher order thinking skills such as synthesis and evaluation, and a personal commitment to learn the material, not simply learning for the sake of a good grade (Biggs, 1987; Entwistle, 1981; Tagg, 2003; cited by Floyd et al., 2009). This definition bears strong resemblance with intrinsic motivation, and autonomous regulation. The main difference is that Marton & Säljö's definition regards the

end goal; learning, while intrinsic motivation describes the process. In contrast, surface learning represents avoidance of failure with minimalistic effort and involvement (Cano, 2007). Draper (2009) argued that surface learners understand the material correctly, but does not possess the connections between concepts that deep learners do. Deep learners are able to transfer the knowledge to a variety of situations consequently increasing their understanding.

Pluck & Johnson (2011) argue that there is a strong link between information gap research and theories that propose distinctions between deep and surface learning. Craik & Lockhart (1972) argue that "deep" processing of information will have an enhance learning outcome.

Learning in education. Children spend much of their days learning, either on their own through questions, exploration, or mediated by an external source, which in the educational setting is a teacher. Teachers help control the children's learning process and help them self-regulate their behavior and motivation, often by employing different learning strategies with focus on continuous learning and adaptation (Dixon, 1994; Fullan & Miles, 1992).

Robinson & Hullinger (2008) reported that A-students and students who were satisfied with their university experience reported higher level of engagement, as well as more frequent use of higher order thinking skills such as analysis, synthesis, and making judgements. The outcome of these findings is further support that students who are engaged, or motivated (Richardson & Newby, 2006), also report high levels of deep learning.

Reporting effects on learning. As mentioned, learning was assessed from two perspectives: the direct self-reported learning outcome, and the perception of competence regarding learning.

Confirming one the study's hypothesis, learning outcome significantly correlated with intrinsic motivation, with a strong relation measured in the interest, perceived choice and value facets. Likewise, self-regulation positively correlated with learning outcome. Upon inspection of the facets, only autonomous regulation was found to correlate with learning outcome, while controlled regulation did not. These findings support the theory of Ryan & Deci (2000a) that autonomous regulation is a reflection of intrinsic motivation.

Perceived competence for learning was found to correlate, curiosity, intrinsic motivation and self-regulation, consequently confirming several of the study's hypothesis. Of the intrinsic motivation facets, perceived choice and value was found to correlate with perceived competence for learning. Interestingly, only the controlled regulation facet of self-

regulation depicted a relationship with perceived competence for learning. Opposing autonomous regulation, controlled regulation is considered to be in close relationship with extrinsic motivation (Ryan & Deci; 2000a). While learning outcome catered only to intrinsic findings, perceived competence for learning seem to be a result of both intrinsic and extrinsic motivation and regulation.

Both facets of curiosity, along with curiosity itself, was found to significantly correlate with perceived competence for learning. Though curiosity was hypothesized to correlate with both learning outcome and perceived competence for learning, there was only found a significant relation with perceived competence for learning in this study, which indicate that though the measurements are variations of the same concept, namely learning, they do not measure the exact same thing. Consequently, a dimensional learning framework could be useful to employ in future studies to assess accurately how curiosity affect learning.

One curious results were found with the absorption facet of curiosity in the pre-test group. Here, absorption depicted a negative correlation with learning outcome. While this outcome is not found anywhere else in the study, it could be a reflection of Bowler's study (2010), which argue that full absorption in a topic without constraints could have a negative impact on the learning outcome as a whole due to limited time. However, this explanation would fit better if the result occurred in the control group or experiment group, and not the pre-test group which was not affected by any time limit.

Although there were limited findings in this study between the different test groups, correlational results were found between several variables. As mentioned, some findings were more expected to correlate than others, especially perceived competence and perceived learning competence. This can be attributable to the similarities of the terms along with some similarities in regards of the survey questions.

The lack of curiosity's correlational effect on learning outcome was surprising. The similar findings between the pre-test groups and post-test groups can suggest that there was little difference between the intervention of curiosity and the curiosity elicited by the teacher in regular class. A positive finding for the sake of this study's hypothesis is the significant correlations between the exploration facet of curiosity and perceived competence for learning among all test groups. These results suggest that the exploration facet, as theorized, does play a vital part in learning, or specifically the individual's perception of ability to learn.

Value

Learning in itself is not a product of one thing. Motivation, curiosity, interest, value; neither can by itself explain how learning works, and will never be the sole reason for learning to occur. While the listed concepts undoubtedly are important for some variations of learning, there can be other factors that influence the outcome as well. In this study there will be no attempt to clarify all factors that may influence learning in an educational setting, but will emphasize how the measured items and applied scales contribute to learning, and equally important, how this can be applied to academic contexts.

Parts of motivation to complete any task, or to learn something, is based on the individual's notion of the subject's importance, or what value the material possess (Ryan & Deci, 2000a). For instance, students preparing for an exam might find that they do not have the time or resources to read the entire curriculum and have to select a few books. What the student may choose will largely be based on the value the student grant certain pieces of information.

Greene, Fairclough, & Haines (2014) discuss in their article students perceived value of general and specific learning objectives, and found that students prefer specific learning objectives, and that perceived usefulness of learning objectives increased when presented with specific learning objectives. Furthermore, a significant correlation was found with specific learning objectives and grades. Students who preferred specific learning above general learning tended to have better grades than those who preferred general learning objectives. These findings are brought up to exemplify how value or perceived importance might affect learning. The notion that use value to actively study relevant curriculum is supported by Bishop & Pflaum (2005), who argue that value facilitates engagement and that engagement and perceived value increase deep learning.

Floyd, Harrington, & Santiago (2009) found a significant correlation between perceived course value, student engagement, and deep learning strategy. The found that surface learning strategies are employed among students who have a low perception of course value. Value was found in this study to have a greater positive influence on deep learning surface learning strategies than engagement. Since the study employs Richardson and Newby's definition of cognitive engagement (2006) as the integration and use of students' motivations and strategies in the course of their learning, they define an engaged student as a motivated student (Floyd et al., 2009). Floyd and colleagues (2009) note that though a student may see value in a course, the student may not be fully engaged in its content. Motivation is

theorized to be of great importance to learning, and expectedly so is value (Bishop & Pflaum, 2005; Floyd et al., 2009).

Hulleman (2007) discovered that when students were asked to apply the course material to their own lives, the students reported an increase in perception of value, subsequently promoting interest and performance in the classroom. The increase was especially high among the students with lower levels of belief in their own abilities, which raises questions of the link to perceived competence. This study found a strong correlation between value and perceived competence for learning, thus supporting Hulleman's findings. However, this support only function in regard to student learning, as there was no significant correlation between value and perceived competence. Course value is regarded intrinsic if the course is fun and enjoyable, but utilitarian if the course is mostly perceived as important to other aspects of the student's life (Hulleman, 2007).

Rossing & Long (1981) discovered that students, in choosing education courses, found the perceived value of information was considered the most important reason to learn more, increasing support for value's role as a facet of intrinsic motivation and its link to learning.

Neuroscience

Learning have been an important focus in neuroscience since the fields beginning. Edelman (1993) proposed the Neural Darwinism theory which through reentry allows an individual to learn from environmental stimuli from a neurophysiological perspective. However, intrinsic motivation has in the past few years received attention in the neuroscientific field and is consequently a huge step for motivational research. Domenico & Ryan (2017) argue that experience and behavior is mediated by the brain, thus intrinsic motivation needs an understanding of the neural network that supports it. Furthermore, neurological examination presents data of internal processes that are not accessible from self-reports or behavioral observation, which formerly have been the main approach to investigating intrinsic motivation, as well as curiosity (Ryan & Domenico, 2016; cited by Domenico & Ryan, 2017).

Gray & McNaughton (2000; cited in Domenico & Ryan, 2017), in their theory of septo-hippocampal anxiety, present an alternative path on motivation. They discovered that novel stimuli represent potential of both reward and punishment, evoking both avoidance and approach, thus inducing anxiety due to the uncertainty of the situation, yet promotes cautious investigatory behavior to resolve the risk by scanning the environment and one's memory. This theory does not stray far from the early theories of curiosity where participants felt

anxious of novelty, or the theory of which curiosity was considered unpleasant until gratification (Berlyne, 1954; 1960; Loewenstein, 1994), yet sheds new light from the field of neuroscience. In other studies of intrinsic motivation, there has also been found that too much novelty relative to an individual's skill and knowledge produces anxiety, whereas too little novelty evoke boredom (Harlow, 1953; White, 1959; cited by Domenico & Ryan, 2017; Deci & Ryan, 1985). Intrinsic motivation predominates over anxiety and boredom, and these findings indicate that intrinsically motivated exploratory and mastery behaviors are mainly stimulated by interest and sating mastery needs, not anxiety reduction (Domenico & Ryan, 2017).

SEEKING System. The mesolimbic dopaminergic (ML-DA) system have been connected to motivational behaviors, reward, and cognitive processes (Alcaro, Huber, & Panksepp, 2008). DA have been recognized for its involvement in regards of goal-directed behaviors and in promoting and reinforcing learning. The affective neuroethological perspective presents the ML-DA system in terms of its ability to activate an instinctual emotional appetitive state, known as SEEKING, which motivates animals to search for all possible life-supporting stimuli and avoid harm (Panksepp, 2004), and other actions to facilitate survival (Panksepp & Biven, 2012; cited by Domenico & Ryan, 2017).

Ryan & Domenico (2016; cited by Domenico & Ryan, 2017) suggests that the concept of intrinsically motivated exploration is consistent with the affective neuroethological perspective. The SEEKING system continuously manages animals in a state which they explore the environment. They further argue that the SEEKING system functions as an objectless appetitive system until the exploratory activities results in discovery and learning with usefulness.

Studies exploring the SEEKING system in rats (Panksepp, 1998; Panksepp & Biven, 2012; cited by Domenico & Ryan, 2017) demonstrate that the ventral tegmental area (VTA), the nucleus accumbens (NAcc), the ventromedial prefrontal cortex (VMPFC), and the dopaminergic projections originating from the VTA that innervate these areas are brain regions often referred to as the "brain reward network". White (1959; cited by Domenico & Ryan, 2017) discovered that electrical stimulations to these areas led to invigorated searching behavior similar to curious exploration rather than calm satiation. Panksepp & Biven (2012; cited by Domenico & Ryan, 2017) noted that animals getting this kind of stimulation would frantically explore their surroundings, noting all the novel stimuli they face. The SEEKING system unfolds urges into complex forms of exploration and is believed to stimulate many

mental complexities that humans experience as feelings of interest, curiosity, sensation seeking, and the search for higher meaning (Panksepp, 1998; cited by Domenico & Ryan, 2017).

It seems that the SEEKING system both employ extrinsic and intrinsic motivation, and it is interesting how exploration, curiosity and motivation collaborate from a neurological perspective, which differ greatly from self-reports, yet reach many of the same conclusions.

However, also suggested through neuroscience is that exploratory behavior is not all beneficial. Alcaro et al. (2008) explain that the SEEKING disposition affect attention, incentive salience, associative learning, and anticipatory predictions, which includes that the rewarding properties of drugs are partially caused by the activation of the SEEKING system. This is explained by the appetitive drive and persistent craving depending on the intensity of the affect.

Neurological support for intrinsic motivation. Domenico & Ryan (2017) proposed that due to the complexity of intrinsic motivation which spans through cognition, affection, and behavior, it is probably guided by several neural structures and processes. The hypothesis is that dopamine is the key to understanding intrinsic motivation from a neurological perspective. This assertion is mediated through the active use of the SEEKING system, which the exploratory activities are often employed by intrinsic motivation. Furthermore, dopamine is a large part of the neurochemistry of this system (Panksepp, 1998; Panksepp & Biven, 2012; cited by Domenico & Ryan, 2017). Dopamine, like intrinsic motivation, is correlated with increased positive affect, cognitive flexibility, creativity (Ashby, Isen, & Turken, 1999), behavioral persistence (Salamone & Correa, 2016; cited in Domenico & Ryan, 2017), and exploration towards novelty (DeYoung, 2013). Berridge (2007) note that the positively affected states associated with dopamine is related to energized appetitive “wanting”, not consummatory “liking”, which are guided by opioids. With the usage of positron emission tomography, de Manzano and colleagues (2013) discovered that intrinsically motivated flow states in daily activities are connected to dopamine D2-receptor availability in striatal regions, especially the putamen. This advocate that individual’s capacities for intrinsic motivation are related to the number of targets within the striatum for dopamine to act upon. Supporting the proposal that dopamine is correlated with intrinsic motivation, Gyurkovics and colleagues (2016) discovered that carriers of a genetic polymorphism that affect striatal D2-receptor availability were more liable to experience flow during study- and work-related activities.

Better understanding of the neurological correlation with intrinsic motivation could yield a greater resolution of the processes that enhances high quality learning and performance.

This neurological SEEKING system bears clear resemblance to Kashdan and colleagues' (2004) exploration facet of curiosity, and whether it remains within the bounds of Domenico & Ryan's (2017) suggestion of intrinsic motivation or Kashdan and colleagues' (2004) understanding of curiosity, the SEEKING system can to some degree explain the exploratory behavior that have been theorized to positively affect learning, but from a neuroethological perspective.

It should be noted that intrinsic motivation is a relatively new concept in regards of neuroscience and needs further studies to accurately depict the relationship between intrinsic motivation, SDT, and dopamine, not to mention curiosity and learning.

Trait Theories

The "Big Five" model of personality have formed a concept similar to intrinsic motivation, specifically plasticity, which represents stable interindividual differences in exploratory tendencies. While intrinsic motivation refers to a motivational state, and plasticity to a dispositional state, they share commonalties. DeYoung (2010) states that plasticity contains being actively engaged with the possibilities of the environment, both generating and attending to novel aspects of experience. Individuals with high scores of plasticity are thought to have inclination towards exploring for its own sake, even without obvious goals (DeYoung, 2013).

Naylor (1981) attempted to classify curiosity as a state or a trait feature. However, Coie (1974) argued that curiosity is not a stable personality trait that will remain unwavering across contexts and situations. Pluck & Johnson (2011) argued that while focusing on individual differences might be of academic interest, the applied situations of curiosity, such as teaching, it would be beneficial to understand how curiosity is stimulated in order to enhance the probability of learning. Thus, cognitive approaches can be more informative to applied situations as they examine how individuals construct their own realities (Neisser, 1976). The individuality in the concept of curiosity is presented in Berlyne's (1954) theory of epistemic curiosity, and further developed and explained in Loewenstein's (1994) theory of information gaps, which in turn roots in Gestalt theory; the principle that closure motivates completion of items that are missing parts (Koffka, 1935). The theory was originally related to perception and illusion, but it merged well with Loewenstein's information gap theory of curiosity. Loewenstein's theory has been operationalized (Gentry et al., 2002) to include to

features: (1) how confident the students are about their current knowledge on the topic, and (2) how important learning about the topic is to the individual. The latter item is summarized in this study's measurement of value.

Like with most psychological concepts, people are different in terms of curiosity, and researchers have attempted to measure the difference from a variety of perspectives. Openness to experience is a typical example, presented as a heterogeneous higher-order trait, but Kashdan et al. (2018) argue that openness to experience is much more that curiosity. In terms of measure, curiosity is presented as a single facet in many contemporary trait models such as the Big Five personality trait model (McCrae, 1996; cited by Kashdan et al., 2018), the HEXACO model (Ashton & Lee, 2007), and the theoretical intellect framework (Mussel, 2013; cited by Kashdan et al., 2018). A tacit understanding regarding trait curiosity is the manifestation of frequent and/or intense momentary episodes of curiosity (Boyle, 1989; Silvia, 2008). However, as discussed, few studies that assess curiosity as a concept of its own and not as a facet of another framework will consider curiosity to only have one dimension.

Curiosity Trait Theory

As mentioned, this study hypothesized that there would be a difference between the experiment groups, hoping to determine that curiosity reported significantly higher levels in the experiment group contrary to the control group and pre-test group. However, as the results indicate, no such findings were found mainly due to the violation of sphericity, which could arguably be resolved through the increase of sample size. A different approach to what could limit the results is examining trait theories. Instead of proposing curiosity as a state theory, as measured in this study, Kashdan and colleagues (2018) introduce the possibility that curiosity is not a state, but rather based on personality. They found five different dimensions of curiosity, and furthermore categorized people by four curiosity groupings.

Interpersonal Curiosity

A somewhat different perspective appears in Sinha, Bai, & Cassell's (2017) book, which argue that curiosity isn't necessarily evoked through only individual activities, but also interpersonal activities. Sinha et al. (2017) provides a new theoretical framework that express an integrated socio-cognitive account of curiosity. They found a stronger influence from interpersonal functions than individual functions on curiosity, which in many ways is a new direction for a primarily individual-based term. A child, or adult for that matter, may experience uncertainties evoked by peers. Both children may actively work together to gain knowledge to fill their gaps, thus positively impacting their curiosity. Typically, this happens

more often with older individuals as well, where a group discuss a topic none is familiar with, but to conclude the discussion, one or more researches the topic on their phone and sates their curiosity, which was brought to their attention through a social context.

Social Curiosity

Humans are a social animal who continually through their life find partners, forge friendships, and attain social status in a variety of hierarchies, and curiosity plays a vital part. The interest in knowing other people's feelings, thoughts and behavior can be understood as social curiosity (Renner, 2006). Most human behavior occur in context of the relationship that person holds with other people.

High levels of social curiosity indicate tendencies to gossip (Litman & Pezzo, 2007), and the accuracy of interpersonal perceptions about strangers (Hartung & Renner, 2011). However, socially curious individuals often report friendly behavior that instigate friendships, such as being agreeable and friendly. Friendly behavior, however, does not fulfill the need to belong, or feelings of connection with other people.

Kashdan and colleagues (2018) found that stress tolerance is inversely related to social curiosity, which may stem from an awareness of a gap between social knowledge that an individual possess and desires. This gap may be more relevant for people who are less comfortable handling the uncertainty of sociality and seek knowledge about normative behavior according to the culture in question.

Cooperation and Social Play

SDT apply intrinsic motivation as a broad spectrum for a diversity of activities that in some way can be considered inherently rewarding and growth promoting. As discussed in this study, it includes curious exploration and mastery tendencies, but also social play (Ryan & Domenico, 2016; cited by Domenico & Ryan, 2017).

Social play, related to intrinsic motivation, have gained less attention from neuroscientific studies than its counterpart, namely curious exploration and mastery tendencies. However, the subcortical PLAY system, replacing the SEEKING system, governs the rough-and-tumble interactions of animals, prompting development and refinement of physical, emotional, and social competencies in a safe context (Panksepp, 1998; Panksepp & Biven, 2012; cited by Domenico & Ryan, 2017).

The relevancy between social play and curiosity and learning may not seem obvious at first glance, but social play can be perceived as learning in forms of socialization and later cooperation. Peterson & Flanders (2005) argue that rough-and-tumble play constitutes a type

of social cognition that provides a foundation for cooperation and the adaptive self-regulation of aggression among mammals.

Due to interaction between the PLAY system and basic motivations, Ryan & Di Domenico (2016; cited by Domenico & Ryan, 2017) concludes that play is an intrinsically motivated socialization and an expression of people's complementary tendencies toward autonomy and sociality in development (Ryan, 1995; Ryan, Kuhl, & Deci, 1997). This play well with the SDT, which in addition to competence and autonomy, suggest the need for relatedness, meaning the sense of feeling connected to others in a meaningful way (Ryan & Deci, 2017; cited by Domenico & Ryan, 2017). Contrasting to competence and autonomy, relatedness has not played a significant role in explaining intrinsic motivation. Yet, relatedness is often seen among children, providing a sense of safety, a secure base of from which the children can explore (Ryan & Deci, 2017; cited by Domenico & Ryan, 2017). Thus, both PLAY system and relatedness can be expressed as intrinsic motivation, however, this seems to be more apparent in children.

The ambiguity of play. It should be noted that many behavioral models of human intrinsic motivation have combined exploration and play due to commonalities between the terms, such as internal perceived locus of causality and perceived competence. Domenico & Ryan (2017) suggested that many intrinsically motivated activities can be recognized by many as playful, thus the conflation is appropriate and productive. Wilson (2000) discuss that in exploration the animal or child focus on the nature of the object, but in play, the animal or child emphasize the possible usage of the object.

Types of Curious People

Kashdan and colleagues (2018) discuss the possibility of different types of curious people. The argumentation is that individuals are different in terms of curiosity in daily activities, and what subcategories of curiosity best fits a person's profile. The four clusters of curious people are the fascinated (1), problem-solvers (2), empathizers (3), and avoiders (4).

The fascinated represents the embodiment of curiosity; someone who explore, develop passionate interests, and uncover their full potential (Kashdan et al., 2004; Mussel, 2013; Silvia, 2008). They score high on all subscales of the five-factor model of curiosity, with highest scores on joyous exploration and lowest score on deprivation sensitivity. These people are very likely to find the feelings of curiosity and exploration as pleasurable. This group represented 28% of the population.

The problem-solvers distinguish themselves with having high scores on joyous exploration, deprivation sensitivity, and stress tolerance, but have very little social curiosity. This group also represented 28% of the population.

The empathizers have a high level of social curiosity, joyous exploration and deprivation sensitivity, but are relatively lower on stress tolerance and thrill seeking. This cluster consists of more women than men, and they often characterize themselves as neurotic and frequently stressed, but also more agreeable than the other clusters. This group represented 25% of the population.

Finally, the avoiders score lower on almost every dimension of the five-factor model, scoring highest on deprivation sensitivity, and lowest on stress tolerance and thrill seeking. Socioeconomically, this group represents the least educated and earn less than the other clusters. This group represents 19% of the population in the study (Kashdan et al., 2018).

What these findings represent besides exploring how people are different in terms of curiosity, what they value, and how they employ curiosity, is that Kashdan and colleagues (2018) revive the possibility that curiosity isn't limited to situations, but can be relatively stable traits. While this isn't a new theory (Boyle, 1989), it is among the first to empirically explore the possibility, next to the Big Five personality model which includes exploration, a facet of curiosity, as a minor subscale of openness (DeYoung, 2010).

"Monkey see, monkey do" is an adequate summarization of the learning process in children and it should come as no surprise that children are curious to learn given the amount of novel stimuli presented to a child compared to an adult. Kashdan and colleagues (2018) found stability among their four dimensions of curiosity, however further studies should address the applicability of these curiosity dimensions on children, who are less formed by personality traits than adult.

It is important to address the possibility of a personality-based curiosity model, as it will most likely play a very different role from an event-based curiosity model in terms of learning. Consider that in case of trait-based curiosity, applying curiosity to an educational setting would present issues with how to include every group in a specific learning strategy designed to inspire curiosity. Furthermore, it raises the question of whether it is possible to change the avoiders cluster to another group, which promotes exploration and learning.

In this study, curiosity was approached from an intervention-based perspective, and curiosity was intended to be promoted in the experiment group by altering the learning environment through inspiration and choice. However, the results indicate that there was little

to no difference between the groups. If the theory presented by Kashdan et al. (2018) holds ground, these findings should have been expected, curiosity would not differentiate in a significant degree due to being relatively stable traits originating in dimensional clusters of curiosity.

However, other measured factors were not considered stable traits, specifically intrinsic motivation, yet wasn't found to significantly digress from the control group. Consequently, the hypothesis remains in debate, and it would be premature to accept the null hypothesis.

Five Dimensions of Curiosity

An issue with curiosity in terms of definition is that researchers still apply a wide variation of theoretical frameworks to measure curiosity. These involves the factors presented by Berlyne (1954), epistemic and perceptual curiosity, which lay much of the foundations of our understand of curiosity. In the last two decades, the CEI and CEI-II was developed (Kashdan et al., 2004; Kashdan et al., 2009), which included the factors exploration and absorption; and stretching and embracing, respectively; and now, these past months, a new five factor framework has been developed. This new model attempts to combine theories of Loewenstein (1994) and Berlyne (1954) with Kashdan et al. (2004; 2009) by including the possibility of viewing curiosity as a stressful experience. The five factors are joyous exploration, social curiosity, stress tolerance, deprivation sensitivity, and thrill seeking (Kashdan et al., 2018). The broadness of the new framework allows for more concept similarities as discussed earlier. While thrill seeking or sensation seeking often have been viewed as its own term, the newly proposed scale expresses a holistic view, which may appear as an upcoming umbrella term.

However, the new scale is arguably still under development as some factors such as social curiosity and thrill seeking, and their subordinate items, did not perform as well as items from the other dimensions (Kashdan et al., 2018). Perhaps this broad scale of curiosity what is really needed to fully understand curiosity as a whole. Examining the past century of curiosity research, the study by Kashdan and colleagues (2018) may be a much-needed step in the right direction to reach a taxonomy for curiosity that researchers can agree upon.

Kashdan and colleagues (2018) discovered that individuals scoring high on joyous exploration and stress tolerance represent high levels of openness and emotional stability, grit, happiness, meaning in life, psychological flexibility, satisfaction of the needs for competence,

relatedness and autonomy, and have a healthy reaction to distress. These findings represent a comprehensive reflection of well-being correlated to curiosity.

Furthermore, they found that deprivation sensitivity correlated strongly with Berlyne's epistemic curiosity (1954), known as the drive to know, and with the belief that a good life consists of working to achieve one's potential and encourage knowledge rather than pursuing positive experiences. Deprivation sensitivity showed the strongest correlation among the five factors to anxiety. Thrill seeking stands out from the other factors, as it is not about learning or growing such as joyous exploration or deprivation sensitivity, but relies on the belief that a good life stems from seeking pleasure and adventure, especially when a physical, social, legal, or financial risk is present (Kashdan et al., 2018).

Well-being of Curiosity

Individuals endorsing greater dispositional curiosity have a higher probability to experience pleasurable and meaningful moments in their lives (Gallagher & Lopez, 2007; Kashdan, Sherman, Yarbo & Funder, 2013). Part of these moments of well-being are the outcome of curiosity facilitating greater effort toward exploration, discovery, and personally meaningful goal pursuit in curious individuals (Kaczmarek et al., 2013; Mussel, 2013; Sheldon et al., 2015). Kashdan and colleagues (2018) discovered in their five factor scale of curiosity that joyous exploration and stress tolerance was most relevant to well-being, supporting the former research.

Findings Between Groups

Through examination of the data by a repeated measures design, problems arose with sphericity. As the Mauchly's test dictated a violation of sphericity, this study is unable to conclude any meaningful effect of the intervention of the test groups due to the resulting decrease of validity and power. Therefore, it is a large probability that the null hypothesis remains true. These findings may suggest that there is no relation between the groups and subsequently that the study failed to alter the levels of curiosity in the experiment group to a significant degree. However, another likely possibility is that the small sample size deters the findings, and that a larger sample size could be beneficial to accurately depict the relationship between groups.

Alternatively, as Kashdan and colleagues (2018) propose, curiosity consists of a variety of dimensions not tested, which in turn could yield very different results between group.

Intelligence and Curiosity

Hogan & Greenberger (1969) and Hoepfner & O'Sullivan (1968) both found a relationship between social intelligence and I.Q., further arguing that a child with high I.Q. will in most cases have a high curiosity score. Note the unique adjective-based study. It may be the "halo effect" or bias that affect these results. Also note that former studies by Day (1968; cited by Hogan & Greenberger, 1969), and Penny & McCann (1964), found no significant correlation between curiosity and standardized measures of intelligence. The author of the Hogan paper argues that this is partly due to the differences in measurement, but he also argues that the correlation between I.Q. and curiosity decline with age among some children. This argument raises interesting question of relevance to this study. For instance, how different would the results have been if this study was carried out on first grade students at an elementary school instead of a high school?

Thomas Friedman (2007; cited by Pluck & Johnson, 2011) argued that curiosity combined with motivation is more important than intelligence regarding educational achievement. Though intelligence undoubtedly could be beneficial in academic settings, a lack of motivation can restrict engagement in the learning process, limiting achievement. Contradicting to Friedman's statement, Day (1968; cited by Pluck & Johnson, 2011) found that IQ is more important than curiosity in predicting grades.

Intellect in curiosity scales. Powell, Nettelbeck, & Burns (2016) found a strong correlation between need for cognition, typical intellectual engagement, epistemic curiosity, which together, they propose, measure intellectual curiosity.

Powell and colleagues (2016) also debated curiosity and multiple construct similarities with other concepts, specifically with Need for Cognition (NFC) and Typical Intellectual Engagement (TIE). NFC can be defined as an individual's need to understand of the experiential world (Cohen, Stotland, & Wolfe, 1955; cited by Powell et al., 2016), or the tendency to engage in and enjoy thinking (Cacioppo & Petty, 1982). TIE is defined by Goff & Ackerman (1992; cited by Powell et al., 2016) as "a personality trait hypothesized to relate to typical vs. maximal intellectual performance". The NFC and TIE scales have been found to have similarities with the Five Factor Model variables and autonomous regulation in learning measures (Woo, Harms, & Kuncel, 2007). While taking a different approach than Kashdan et al. (2018), Powell and colleagues (2016) indirectly support the theory that curiosity can exist as a stable trait.

Mussel (2010), however, argue that the association is due to NFC's Reading factor, thus the scales are different enough to integrate the measures to a broad framework. Mussel (2013; cited by Powell et al., 2016) created such a framework later on, which incorporates existing measures of intellectual curiosity. Unlike other frameworks, such as the five-factor model of curiosity, the SDT, or scales such as CEI-I and CEI-II, this framework emphasize intellect, spanning across two dimensions: Process and Operations. Process refers to consecutive phases in performing an action, and consists of two subscales: Seek, the desire for novel intellectual challenges, and Conquer, the desire master current domains of knowledge. Operations refers to an individual's preference for engaging in different intellectual activities. The subscales are labeled Think, Learn and Create, and was developed as counterparts of aspects of intelligence theory, where Think parallels fluid intelligence, Learn parallels crystallized intelligence, and Create parallels creativity (Mussel, 2013, cited by Powell et al., 2016). One of the reason it is important to emphasize this theoretical perspective of curiosity, is that the framework already assumes a positive correlation between curiosity and learning, or at least intellectual stimulation. Another reason is to address that researchers over the last five years still have not come close to a mutual understanding of curiosity in terms of measurement, definition, and limitations.

Powell and colleagues (2016) supports the theory of intellectual curiosity and found similar findings to Mussel (2013). They, however, included Reading in their scale, but found it to be an independent factor, sharing little with the other factors, and thus could not be incorporated within the Intellect domain. The exclusion is rather controversial as reading is a typical behavior among active minds (Powell et al., 2016). Powell et al. (2016) argues that the TIE scale was developed at a time where information-seeking habits emphasized reading books and magazines, and by updating the scale to include screen-reading habits might increase relevancy of the factor.

Powell et al (2016) also found no evidence that TIE, NFC, or Epistemic Curiosity (EC) measure creativity, they argue that future research should investigate creativity's role in academic and workplace performance, which von Strumm, Hell, & Chamorro-Premuzic (2011) and Mussel (2013) found IC to predict, respectively.

Curiosity Beyond Education

While reviewing curiosity it may appear that the topic is mostly – or only – of interest to educators, researchers and possibly psychologists. However, the applications of curiosity are tremendous and can be applied to seemingly unrelated fields. Business firms can for

instance apply curiosity with commercials, product placements, or even the product itself. Increasingly relevant is a completely different field; programming, or more specifically, search engines. Though the ethical conundrums will not be discussed in this study, search engines are becoming increasingly effective at reviewing search history to expeditiously suggest further topics. The knowledge thirst and exploratory behavior often linked with curiosity and information gaps can be provided by search engines and consequently can improve learning.

Video games also employ curiosity and intrinsic motivation, especially in the form of exploration, where more often than not this is rewarded and sometimes used as a means to learn about the game's world and story. Furthermore, freedom of choice is often emphasized to increase interest. Assuming that most people who actively play video games employ intrinsic motivation as there are rarely extrinsic rewards associated with the activity below a professional level, it can prove to be beneficial to implement or alternatively promote or create video games with a premise of learning.

Computer enhanced learning. Wu & Miao (2013) created computer systems with a purpose to facilitate task performance through enhancing an individual's curiosity. As intrinsic motivation, exploratory behaviors, and learning outcomes is not only caused by materials available to the child, but also through the work of other children, social and cultural environment, and the presence of facilitators, these systems could prove beneficial not only to learning, but also to cooperation and early socialization processes among children.

Curiosity in the workplace. Curiosity is employed in many different aspects of our lives, and can affect work, vacations, roles, creative thinking and much more. Zuckerman (1994) researched sensation seeking and the willingness to take financial, physical, and social risks in order to acquire novel experiences.

In the workplace, different approaches have been made. Mussel, Spengler, Litman, & Schuler (2012) measured individual differences in curiosity at work, while Mussel (2013) reviewed job performance, which argue that curiosity can be attributed to predict job performance. Acting on curiosity has been found to increase knowledge, build competencies, promote social relationships, and increase intellectual and creative capacities in the long term, as well as academic achievement (von Strumm, Hell, & Chamorro-Premuzic, 2011), and exploratory behavior (Litman, Hutchins, & Russon, 2005).

Limitations and Future Studies

Due to the cross-sectional character of the data, it is impossible to determine causality of the relations between the correlated findings in this study. The purpose of the study was to find connections between the concepts curiosity, intrinsic motivation, and learning, but is also limited to this. Further study is necessary to emphasize the direct causality between the terms, in which this study could not due to limited sample size.

This study employed narrowed down alternatives to fully developed framework measurements. By using a larger measure, it is possible that the study would been given a more accurate representation of each factor. However, due to the length of some scales, it could very well prove to be redundant.

Though scales such as Relatedness from the SDT were expected to have little impact on this study, it would be of scientific interest to address the full measurement of each framework employed in this study. Furthermore, it may increase construct and content validity. Perhaps relatedness would score well in a future study concerning social curiosity.

It was unexpected that curiosity displayed the highest outcome in the pre-test group, however it is worth noting that the curiosity may been affected in the pre-test group as the researcher had recently presented the questionnaire and the students were curious of the subject. This may indicate other limitations of the study, as the students may have experienced a spike in curiosity due to the novelty of the situation and not necessarily experience increased curiosity for the course.

For future studies, to remove the novelty factor of a survey or researcher, it may be beneficial to participate with the class several times in advance to induce a familiarity factor. Alternatively, approach students used to complete several questionnaires, e.g. psychology students. However, the latter approach will limit the possibility to generalize, as future studies should also include a larger and more diverse sample size.

Note that during research for this paper, to eliminate possibilities of confirmatory bias, multiple searches for contradicting findings were utilized. However, I was unable to find any findings that suggested that curiosity did not positively affect learning.

While this experiment counted on curiosity to arise by introducing a topic without fully explain it, consequently giving the participants a desire to fill the knowledge gaps, there may have been other approaches that could be more fruitful. For instance, giving a specific task designed to trigger curiosity rather than giving participants free will to gather the information themselves could give more diverse test group results. Since the purpose of the

study is educational, it could also be of interest to view the interaction between cooperation and curiosity, especially since some studies (Sinha et al., 2017; Hartung & Renner, 2011) argue that interpersonal activities also evoke curiosity. In this study, though the students were given free choice regarding how to approach the subject, all participants approached the matter individually, and few spoke for the duration of the class hour. It is, however, impossible to draw any conclusion based on qualitative information gained by the researcher due to only observing one class. It would also be of interest to discover what variables interact with curiosity and if the interaction could improve learning. For instance, cooperation is an important part of education, thus the interaction between cooperation and curiosity could be an interesting approach for a future study.

Conclusion

There are many findings that present the positive effects of curiosity and intrinsic motivation on learning (Domenico & Ryan, 2017; Kashdan et al., 2018; Deci & Ryan, 2000; 2002; 2008; Bowler, 2010; Pluck & Johnson, 2011). This study found several correlations that supports this theory, such as a significant relation between curiosity and intrinsic motivation, and between intrinsic motivation and learning outcome, and between curiosity and perceived competence for learning, and some that did not, such as a lack in correlation between curiosity and learning outcome. What greatly troubled this study was the violation of sphericity, and consequently the lack of results between groups.

However, the definition of curiosity and its relation to intrinsic motivation is in dire need to be sorted, as neither concepts can be fully understood unless the core of curiosity and intrinsic motivation is understood separately. Kashdan and colleagues (2018) also argue that curiosity is in need of a synthesis and clear demarcation, arguing that the debate of definition is very much still alive. Whether curiosity is indeed a subsequent concept of intrinsic motivation or not should be a focus for future research.

The debate affects this study as it is difficult to assume whether the lack of significant results between groups stems from fault in the experimental design or if it is due to the possibility that curiosity is a relatively stable trait. Consequently, this study is unable to accept the null-hypothesis as true due to the findings of other researchers (Kashdan et al., 2018) that indicate significant correlation between intrinsic motivation, curiosity and learning.

Furthermore, the experiment attempted to define the causality between curiosity and learning, where curiosity directly leads to an increased learning outcome. However, the study was unable to uncover such results. There are three plausible reasons, which assess why no

significant results were found between groups. The first is that – assuming Kashdan and colleagues' theory (2018) is accurate – state curiosity is difficult to alter through an experimental design due to roots in personality. The second possibility is that the experimental design was flawed, that significant change would appear if the experiment tested several classes instead of only one, then the teacher's teaching style would have been of greater relevance as well. Lastly, the sample size was too small to detect any significant changes between the groups.

A possibility that have not been discussed former in the study or by any articles this paper has examined, is that learning has a causality effect on curiosity. While the logical explanation tends to revolve around curiosity improving learning, consider the possibility of Loewenstein's information gap theory as a sequential concept. The student learns, consequently decreasing the information gap and increasing curiosity, which in turn results in more learning, or deep learning. While this hypothesis suggests that the causality between curiosity and learning goes both ways, note that this study was unable to find a direct causality.

It is regrettable that Kashdan and colleagues' (2018) research came to light after the current study had performed its experiment, as it undoubtedly would affect the experimental design. However, this study may serve as a control for future studies that would test the effects of curiosity and intrinsic motivation between groups.

The study found, as many other studies, a significant correlation between curiosity, intrinsic motivation, self-regulation, and perceived competence for learning, as well as a relationship between intrinsic motivation, self-regulation and learning outcome.

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Survey

Nysgjerrighet og læring

Pre-test

Denne undersøkelsen er en vurdering av din selvvurdering av nysgjerrighet om et emne før undervisning eller annen tilegnelse av kunnskap. Deltakelse er frivillig og anonymt. Svarene vil bli brukt til en masteroppgave i psykologi. Ring rundt hva som best beskriver din tilstand i øyeblikket.

Kjønn:____ Alder:____

Interesse

Jeg tror jeg kommer til like godt å gjøre denne aktiviteten.

1 2 3 4 5 6

Jeg tror at dette kommer til å bli en kjedelig aktivitet.

1 2 3 4 5 6

Jeg tror jeg komme til å beskrive denne aktiviteten som veldig interessant.

1 2 3 4 5 6

Oppfattet kompetanse

Jeg synes vanligvis at jeg er ganske flink i dette faget.

1 2 3 4 5 6

Jeg er vanligvis fornøyd med min prestasjon i dette faget.

1 2 3 4 5 6

Dette er et fag jeg ikke klarer særlig bra.

1 2 3 4 5 6

Oppfattet valg

Jeg tror jeg får noen valgmuligheter ved å gjøre denne aktiviteten.

1 2 3 4 5 6

Jeg tror jeg kommer til å gjøre denne aktiviteten fordi jeg vil det.

1 2 3 4 5 6

Jeg tror jeg kommer til å gjøre denne aktiviteten fordi jeg må det.

1 2 3 4 5 6

Verdi/Nytte av faget

Jeg vil antagelig være villig til å lære mer om emne fordi det har noe verdi for meg.

1 2 3 4 5 6

Jeg tror at å gjøre denne aktiviteten kan være av nytte for meg.

1 2 3 4 5 6

Jeg synes dette er en viktig aktivitet.

1 2 3 4 5 6

Oppfattet kompetanse for læring

Jeg har evne til å lære pensum for dette faget.

1 2 3 4 5 6

Jeg har evne til å nå mine mål for dette faget.

1 2 3 4 5 6

Jeg føler meg i stand til å møte utfordringen av å prestere bra i dette faget.

1 2 3 4 5 6

Selvregulering og læring

Jeg vil delta aktivt i dette faget fordi:

Jeg føler det er en god måte å forbedre mine ferdigheter og forståelse for faget.

1 2 3 4 5 6

Andre ville tenkt dårlig om meg om jeg ikke gjorde det.

1 2 3 4 5 6

Jeg vil sannsynligvis følge lærerens instruksjoner fordi:

Jeg vil få en god karakter om jeg følger lærerens forslag.

1 2 3 4 5 6

Det er viktig for meg å gjøre det bra i dette faget.

1 2 3 4 5 6

Grunnen til at jeg vil fortsette å forbedre meg i dette faget er fordi:

Jeg ville følt meg stolt dersom jeg fortsatte å forbedre meg i faget.

1 2 3 4 5 6

Fordi det er en utfordring å virkelig forstå faget.

1 2 3 4 5 6

Nysgjerrighet og utforskning

Jeg ville beskrevet meg selv som en som aktivt søker så mye informasjon jeg kan i en ny situasjon.

1 2 3 4 5 6

Når jeg deltar i en aktivitet pleier jeg å bli så involvert at jeg glemmer tiden.

1 2 3 4 5 6

Jeg ikke en person som undersøker dypt inn i nye situasjoner.

1 2 3 4 5 6

Når jeg er aktivt interessert i noe, så er det vanskelig å avbryte meg.

1 2 3 4 5 6

Mine venner ville beskrive meg som en som er «svært intens» når jeg er i midten av noe.

1 2 3 4 5 6

Hvor enn jeg går, leter jeg etter nye ting eller erfaringer.

1 2 3 4 5 6

Læringsutbytte

Jeg forventer å lære noe nyttig denne klassetimen.

1 2 3 4 5 6

Graphs

Correlations Table 1

Correlations

		LearnOut	Curiosity	IntrinsicMot	SelfReg	PercCompL	Interest	PercComp	PercChoice	Value	AutoReg	ContReg	Explor	Absorp
LearnOut	Pearson Correlation	1	,025	,565**	,324*	,097	,614**	-,067	,397**	,498**	,388**	,192	,051	-,004
	Sig. (2-tailed)		,856	,000	,014	,472	,000	,620	,002	,000	,003	,152	,704	,978
	N	57	57	57	57	57	57	57	57	57	57	57	57	57
Curiosity	Pearson Correlation	,025	1	,514**	,081	,486**	,319*	,473**	,285*	,336*	-,104	,225	,867**	,902**
	Sig. (2-tailed)	,856		,000	,552	,000	,015	,000	,032	,011	,443	,092	,000	,000
	N	57	57	57	57	57	57	57	57	57	57	57	57	57
IntrinsicMot	Pearson Correlation	,565**	,514**	1	,218	,498**	,812**	,346**	,736**	,739**	,212	,174	,529**	,392**
	Sig. (2-tailed)	,000	,000		,103	,000	,000	,008	,000	,000	,114	,195	,000	,003
	N	57	57	57	57	57	57	57	57	57	57	57	57	57
SelfReg	Pearson Correlation	,324*	,081	,218	1	,277*	,230	-,018	-,104	,475**	,862**	,893**	,116	,032
	Sig. (2-tailed)	,014	,552	,103		,037	,086	,897	,444	,000	,000	,000	,388	,812
	N	57	57	57	57	57	57	57	57	57	57	57	57	57
PercCompL	Pearson Correlation	,097	,486**	,498**	,277*	1	,213	,632**	,162	,403**	,180	,300*	,628**	,261
	Sig. (2-tailed)	,472	,000	,000	,037		,112	,000	,230	,002	,180	,023	,000	,050
	N	57	57	57	57	57	57	57	57	57	57	57	57	57
Interest	Pearson Correlation	,614**	,319*	,812**	,230	,213	1	,010	,547**	,532**	,259	,151	,281*	,284*
	Sig. (2-tailed)	,000	,015	,000	,086	,112		,941	,000	,000	,052	,263	,034	,032

	N	57	57	57	57	57	57	57	57	57	57	57	57	57
PercComp	Pearson Correlation	-,067	,473**	,346**	-,018	,632**	,010	1	-,014	,087	-,059	,023	,595**	,267*
	Sig. (2-tailed)	,620	,000	,008	,897	,000	,941		,918	,520	,663	,863	,000	,045
	N	57	57	57	57	57	57	57	57	57	57	57	57	57
PercChoice	Pearson Correlation	,397**	,285*	,736**	-,104	,162	,547**	-,014	1	,321*	-,164	-,026	,228	,273*
	Sig. (2-tailed)	,002	,032	,000	,444	,230	,000	,918		,015	,222	,849	,088	,040
	N	57	57	57	57	57	57	57	57	57	57	57	57	57
Value	Pearson Correlation	,498**	,336*	,739**	,475**	,403**	,532**	,087	,321*	1	,528**	,318*	,375**	,231
	Sig. (2-tailed)	,000	,011	,000	,000	,002	,000	,520	,015		,000	,016	,004	,084
	N	57	57	57	57	57	57	57	57	57	57	57	57	57
AutoReg	Pearson Correlation	,388**	-,104	,212	,862**	,180	,259	-,059	-,164	,528**	1	,541**	-,052	-,126
	Sig. (2-tailed)	,003	,443	,114	,000	,180	,052	,663	,222	,000		,000	,701	,349
	N	57	57	57	57	57	57	57	57	57	57	57	57	57
ContReg	Pearson Correlation	,192	,225	,174	,893**	,300*	,151	,023	-,026	,318*	,541**	1	,239	,166
	Sig. (2-tailed)	,152	,092	,195	,000	,023	,263	,863	,849	,016	,000		,073	,218
	N	57	57	57	57	57	57	57	57	57	57	57	57	57
Explor	Pearson Correlation	,051	,867**	,529**	,116	,628**	,281*	,595**	,228	,375**	-,052	,239	1	,567**
	Sig. (2-tailed)	,704	,000	,000	,388	,000	,034	,000	,088	,004	,701	,073		,000
	N	57	57	57	57	57	57	57	57	57	57	57	57	57
Absorp	Pearson Correlation	-,004	,902**	,392**	,032	,261	,284*	,267*	,273*	,231	-,126	,166	,567**	1
	Sig. (2-tailed)	,978	,000	,003	,812	,050	,032	,045	,040	,084	,349	,218	,000	
	N	57	57	57	57	57	57	57	57	57	57	57	57	57

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

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

Correlations Table 2

Correlations

TestGroup			LearnOut	PercCompL	Interest	PercComp	PercChoice	Value	AutoReg	ContReg	Explor	Absorp
Pre-test	LearnOut	Pearson Correlation	1	-,045	,514*	-,211	,224	,466*	,541**	,339	-,180	-,517*
		Sig. (2-tailed)		,841	,014	,347	,317	,029	,009	,122	,422	,014
		N	22	22	22	22	22	22	22	22	22	22
	PercCompL	Pearson Correlation	-,045	1	,082	,594**	-,011	,503*	,309	,405	,652**	,274
		Sig. (2-tailed)	,841		,718	,004	,961	,017	,162	,062	,001	,217
		N	22	22	22	22	22	22	22	22	22	22
	Interest	Pearson Correlation	,514*	,082	1	-,170	,415	,560**	,292	,216	,099	,092
		Sig. (2-tailed)	,014	,718		,450	,055	,007	,188	,335	,660	,683
		N	22	22	22	22	22	22	22	22	22	22
	PercComp	Pearson Correlation	-,211	,594**	-,170	1	-,141	,257	-,008	-,050	,699**	,335
		Sig. (2-tailed)	,347	,004	,450		,532	,249	,971	,826	,000	,128
		N	22	22	22	22	22	22	22	22	22	22
	PercChoice	Pearson Correlation	,224	-,011	,415	-,141	1	,234	-,274	-,072	,019	,160
		Sig. (2-tailed)	,317	,961	,055	,532		,295	,217	,752	,932	,476
		N	22	22	22	22	22	22	22	22	22	22
	Value	Pearson Correlation	,466*	,503*	,560**	,257	,234	1	,536*	,321	,416	,064
		Sig. (2-tailed)	,029	,017	,007	,249	,295		,010	,145	,054	,776
		N	22	22	22	22	22	22	22	22	22	22
	AutoReg	Pearson Correlation	,541**	,309	,292	-,008	-,274	,536*	1	,608**	,052	-,366
		Sig. (2-tailed)	,009	,162	,188	,971	,217	,010		,003	,818	,094
		N	22	22	22	22	22	22	22	22	22	22

	ContReg	Pearson Correlation	,339	,405	,216	-,050	-,072	,321	,608**	1	,180	,030
		Sig. (2-tailed)	,122	,062	,335	,826	,752	,145	,003		,424	,894
		N	22	22	22	22	22	22	22	22	22	22
	Explor	Pearson Correlation	-,180	,652**	,099	,699**	,019	,416	,052	,180	1	,453*
		Sig. (2-tailed)	,422	,001	,660	,000	,932	,054	,818	,424		,034
		N	22	22	22	22	22	22	22	22	22	22
	Absorp	Pearson Correlation	-,517*	,274	,092	,335	,160	,064	-,366	,030	,453*	1
		Sig. (2-tailed)	,014	,217	,683	,128	,476	,776	,094	,894	,034	
		N	22	22	22	22	22	22	22	22	22	22
Post-test Control group	LearnOut	Pearson Correlation	1	,224	,781**	,190	,671**	,624*	,544*	,085	,111	,255
		Sig. (2-tailed)		,442	,001	,515	,009	,017	,044	,772	,707	,380
		N	14	14	14	14	14	14	14	14	14	14
	PercCompL	Pearson Correlation	,224	1	,240	,842**	,312	,159	,053	,200	,582*	,236
		Sig. (2-tailed)	,442		,409	,000	,277	,586	,858	,493	,029	,416
		N	14	14	14	14	14	14	14	14	14	14
	Interest	Pearson Correlation	,781**	,240	1	,132	,637*	,610*	,494	-,046	,155	,282
		Sig. (2-tailed)	,001	,409		,652	,014	,021	,073	,875	,596	,329
		N	14	14	14	14	14	14	14	14	14	14
	PercComp	Pearson Correlation	,190	,842**	,132	1	,025	-,053	-,033	,111	,569*	,275
		Sig. (2-tailed)	,515	,000	,652		,933	,856	,911	,706	,034	,342
		N	14	14	14	14	14	14	14	14	14	14
	PercChoice	Pearson Correlation	,671**	,312	,637*	,025	1	,358	,088	,022	,254	,470
		Sig. (2-tailed)	,009	,277	,014	,933		,209	,764	,940	,380	,090
		N	14	14	14	14	14	14	14	14	14	14

	Value	Pearson Correlation	,624*	,159	,610*	-,053	,358	1	,698**	,306	,248	,214
		Sig. (2-tailed)	,017	,586	,021	,856	,209		,006	,287	,393	,464
		N	14	14	14	14	14	14	14	14	14	14
	AutoReg	Pearson Correlation	,544*	,053	,494	-,033	,088	,698**	1	,284	-,232	-,045
		Sig. (2-tailed)	,044	,858	,073	,911	,764	,006		,325	,425	,880
		N	14	14	14	14	14	14	14	14	14	14
	ContReg	Pearson Correlation	,085	,200	-,046	,111	,022	,306	,284	1	,421	,453
		Sig. (2-tailed)	,772	,493	,875	,706	,940	,287	,325		,134	,104
		N	14	14	14	14	14	14	14	14	14	14
	Explor	Pearson Correlation	,111	,582*	,155	,569*	,254	,248	-,232	,421	1	,725**
		Sig. (2-tailed)	,707	,029	,596	,034	,380	,393	,425	,134		,003
		N	14	14	14	14	14	14	14	14	14	14
	Absorp	Pearson Correlation	,255	,236	,282	,275	,470	,214	-,045	,453	,725**	1
		Sig. (2-tailed)	,380	,416	,329	,342	,090	,464	,880	,104	,003	
		N	14	14	14	14	14	14	14	14	14	14
Post-test Experiment group	LearnOut	Pearson Correlation	1	,192	,586**	-,124	,360	,429	,020	,097	,239	,262
		Sig. (2-tailed)		,405	,005	,593	,109	,052	,931	,677	,297	,252
		N	21	21	21	21	21	21	21	21	21	21
	PercCompL	Pearson Correlation	,192	1	,330	,492*	,255	,462*	,060	,213	,679**	,300
		Sig. (2-tailed)	,405		,144	,024	,264	,035	,795	,353	,001	,187
		N	21	21	21	21	21	21	21	21	21	21
	Interest	Pearson Correlation	,586**	,330	1	,096	,596**	,471*	,029	,262	,586**	,454*
		Sig. (2-tailed)	,005	,144		,680	,004	,031	,900	,252	,005	,039
		N	21	21	21	21	21	21	21	21	21	21

PercComp	Pearson Correlation	-,124	,492*	,096	1	,120	-,060	-,190	,092	,520*	,211
	Sig. (2-tailed)	,593	,024	,680		,605	,797	,410	,691	,016	,357
	N	21	21	21	21	21	21	21	21	21	21
PercChoice	Pearson Correlation	,360	,255	,596**	,120	1	,384	-,202	,030	,429	,211
	Sig. (2-tailed)	,109	,264	,004	,605		,086	,379	,898	,053	,358
	N	21	21	21	21	21	21	21	21	21	21
Value	Pearson Correlation	,429	,462*	,471*	-,060	,384	1	,436*	,376	,439*	,386
	Sig. (2-tailed)	,052	,035	,031	,797	,086		,048	,093	,046	,084
	N	21	21	21	21	21	21	21	21	21	21
AutoReg	Pearson Correlation	,020	,060	,029	-,190	-,202	,436*	1	,600**	-,022	,159
	Sig. (2-tailed)	,931	,795	,900	,410	,379	,048		,004	,923	,491
	N	21	21	21	21	21	21	21	21	21	21
ContReg	Pearson Correlation	,097	,213	,262	,092	,030	,376	,600**	1	,259	,265
	Sig. (2-tailed)	,677	,353	,252	,691	,898	,093	,004		,258	,246
	N	21	21	21	21	21	21	21	21	21	21
Explor	Pearson Correlation	,239	,679**	,586**	,520*	,429	,439*	-,022	,259	1	,516*
	Sig. (2-tailed)	,297	,001	,005	,016	,053	,046	,923	,258		,017
	N	21	21	21	21	21	21	21	21	21	21
Absorp	Pearson Correlation	,262	,300	,454*	,211	,211	,386	,159	,265	,516*	1
	Sig. (2-tailed)	,252	,187	,039	,357	,358	,084	,491	,246	,017	
	N	21	21	21	21	21	21	21	21	21	21

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

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

ANOVA Table 1

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
LearnOut * TestGroup	Between Groups	(Combined)	,955	2	,478	,278	,758
		Linearity	,301	1	,301	,175	,677
		Deviation from Linearity	,654	1	,654	,381	,540
	Within Groups		92,764	54	1,718		
	Total		93,719	56			
Curiosity * TestGroup	Between Groups	(Combined)	2,118	2	1,059	1,545	,223
		Linearity	,695	1	,695	1,014	,318
		Deviation from Linearity	1,423	1	1,423	2,076	,155
	Within Groups		37,011	54	,685		
	Total		39,129	56			
IntrinsicMot * TestGroup	Between Groups	(Combined)	,110	2	,055	,149	,862
		Linearity	,003	1	,003	,007	,932
		Deviation from Linearity	,107	1	,107	,291	,592
	Within Groups		19,865	54	,368		
	Total		19,975	56			
SelfReg * TestGroup	Between Groups	(Combined)	,469	2	,235	,486	,618
		Linearity	,000	1	,000	,000	,988
		Deviation from Linearity	,469	1	,469	,972	,329
	Within Groups		26,057	54	,483		
	Total		26,526	56			
PercCompL * TestGroup	Between Groups	(Combined)	,094	2	,047	,031	,970
		Linearity	,060	1	,060	,039	,843
		Deviation from Linearity	,034	1	,034	,022	,882
	Within Groups		81,802	54	1,515		
	Total		81,896	56			

Independent Samples T-Test 1 (between pre-test and experiment group)

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means					
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference

								e	Lower	Upper
LearnOut	Equal variances assumed	2,014	,165	-,380	33	,706	-,167	,439	-1,059	,726
	Equal variances not assumed			-,365	24,009	,719	-,167	,457	-1,110	,777
Curiosity	Equal variances assumed	,347	,560	-,798	33	,430	-,24202	,30317	-,85882	,37477
	Equal variances not assumed			-,767	24,145	,451	-,24202	,31558	-,89315	,40910
IntrinsicMot	Equal variances assumed	,658	,423	-,498	33	,622	-,10917	,21921	-,55516	,33683
	Equal variances not assumed			-,480	24,489	,635	-,10917	,22736	-,57792	,35959
SelfReg	Equal variances assumed	,016	,901	1,040	33	,306	,21357	,20537	-,20425	,63140
	Equal variances not assumed			1,041	28,090	,307	,21357	,20521	-,20673	,63387
PercCompL	Equal variances assumed	,119	,733	,231	33	,819	,09429	,40777	-,73533	,92390
	Equal variances not assumed			,226	25,975	,823	,09429	,41645	-,76179	,95036

Independent Samples T-Test 2 (between pre-test and control group)

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
LearnOut	Equal variances assumed	1,556	,219	,424	41	,674	,165	,388	-,620	,949
	Equal variances not assumed			,425	40,441	,673	,165	,387	-,617	,946
Curiosity	Equal variances assumed	,004	,948	1,060	41	,295	,25012	,23586	-,22622	,72646
	Equal variances not assumed			1,058	40,313	,296	,25012	,23633	-,22741	,72765
IntrinsicMot	Equal variances assumed	,685	,413	-,097	41	,923	-,01694	,17473	-,36982	,33593

	Equal variances not assumed			-,097	40,604	,923	-,01694	,17494	-,37035	,33647
SelfReg	Equal variances assumed	1,999	,165	,026	41	,980	,00565	,22078	-,44022	,45152
	Equal variances not assumed			,026	38,197	,980	,00565	,21912	-,43786	,44916
PercCompL	Equal variances assumed	,487	,489	,202	41	,841	,07526	,37318	-,67839	,82891
	Equal variances not assumed			,202	40,647	,841	,07526	,37193	-,67607	,82659

Test of Sphericity 1

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
TestGroups	Sphericity Assumed	9,686	2	4,843	7,232	,001
	Greenhouse-Geisser	9,686	1,246	7,775	7,232	,006
	Huynh-Feldt	9,686	1,260	7,686	7,232	,005
	Lower-bound	9,686	1,000	9,686	7,232	,009
Error(TestGroups)	Sphericity Assumed	75,001	112	,670		
	Greenhouse-Geisser	75,001	69,763	1,075		
	Huynh-Feldt	75,001	70,579	1,063		
	Lower-bound	75,001	56,000	1,339		