An Investigation of the Role of Goal Setting

During Vicarious Learning of Physics

by

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ABSTRACT

Observational tutoring has been found to be an effective method for teaching a variety of subjects by reusing dialogue from previous successful tutoring sessions. While it has been shown content can be learned through observational tutoring it has yet to been examined if a secondary behavior such as goal-setting can be influenced. The present study investigated if observing virtual humans engaging in a tutoring session on rotational kinematics with embedded positive goal oriented dialogue would increase knowledge of the material and perpetuate a shift an observer's goal-orientation from performance avoidance goal orientation (PAVGO) to learning goal orientation (LGO). Learning gains were observed in pre to post test knowledge retention tests. Significant changes from pretest to posttest occurred across conditions for LGO. Additionally, significant changes from PAVGO pretest to posttest were observed in the control condition however PAVGO did not significantly change in the experimental condition.

Keywords: observational tutoring, performance goal orientation, learning goal orientation

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INTRODUCTION

Video is being utilized more often in online educational settings. However, not all video-based learning environments are created equal. For example, vicariously observing a previous tutoring session has been shown to be more effective than standard monologue videos and even interactive systems (Chi, Roy, & Hausmann, 2008; Craig, Chi, & VanLehn, 2009). Additionally, observational tutoring performs at the same level of expert human tutors and classroom teachers. Due to the potential impact of vicarious learning for improving content acquisition more research needs to be conducted to determine the key elements that facilitate its contribution to learning.

Vicarious learning is the process by which an individual learns by observing material such as watching others perform an action or by overhearing; also called observational learning, in which an individual acquires knowledge by observing another individual during the learning process (Bandura, 1986; Gholson & Craig, 2006). This can include situations such as learning by watching a human (Chi et al., 2008; Craig et al., 2009) or an animated agent, such as a cartoon character or virtual human (Driscoll, Craig, Gholson, Ventura, Hu, & Graesser, 2003; Craig, Gholson, Ventura, & Graesser & Tutoring Research Group, 2000), or listening to dialogue between an instructor and learner (Cox, McKendree, Tobin, Lee, J., & Mayes, 1999; Bandura, 1986)

Through past research subcategories of vicarious learning have emerged; one of the most influential being learning by observing tutoring (Chi et al., 2008; Gholson & Craig, 2006). Tutoring is an instructional method by which a single instructor engages with one or a small number of students versus a larger group to provide more in depth or

specialized instruction. Tutoring is beneficial because it allows for one on one dialogue between the learner and the tutor in which scaffolding of subject material can be systematically applied so errors are detected and misconceptions are corrected. Observing tutoring is an effective method for teaching students various topics and skills such as forming deep-level questions (Craig et al., 2000), collaboration (Rummel & Spada, 2005), as well as learning content (Chi et al., 2008; Cox et al., 1999; Craig, Gholson, Brittingham, & Shubeck, 2012).

However, tutoring is a complex exchange between tutor and the learner(s). There are many factors within the exchange that could provide guidance or scaffolding to a vicarious learner. The current study will focus on the role that goals play during the process.

Goals influence a student's emotion, knowledge acquisition and govern behavior and actions in achievement settings (Pekrun, Elliot, & Maier, 2006). Particularly, within the domain of tutoring, goals serve a distinct purpose of acting as retrieval and selection cues for the learning principles being taught. Due to their significance within the realm of tutoring and learning, the present study aims to examine the influence of observing specific goal-setting techniques of a virtual human tutee. Specifically, the study will investigate if viewing proper goal setting techniques can influence an individual's previous goal orientation and learning.

Vicarious Learning

Humans learn from infancy how to interact with objects, how to react to new people and develop language through vicarious observation of their parents or care givers (Rogoff, Paradise, Meja Arauz, Correa-Chavez, & Angelillo, 2003). As behaviorism

came into popularity, much research was focused on the effects of observational learning. In 1963, Bandura et al., examined the effect of children viewing others, specifically adults, acting violently towards a BoBo the clown blow-up doll. The researchers reported the children who viewed the violent material acted violently towards BoBo, thus supporting the effects of vicarious learning (Bandura, Ross, & Ross, 1963). Several aspects help to reinforce the success of learning through observation, including social reinforcement (Bandura, 1965). Traditionally, vicarious learning has been implemented through direct human observation, videos, animated characters and audio recordings (Bandura, 1986). Vicarious learning has since broadened out into fields such as learning and education, and has developed to incorporate activities such as observing tutoring sessions.

Observational tutoring involves a non-participatory student watching and listening to a dialogue between a tutor and tutee to gain knowledge (Craig, et al., 2008). Several studies have been conducted to examine the effectiveness of observational tutoring. Cox et al., explored re-using dialogue as an educational tool and found that it can be a functional tool for observational tutoring (1999). One of the greatest benefits to observing tutoring is it can be a cost effective method for students to learn (Cox et al., 2009; Chi, Roy, & Hausmann, 2008). The key factor in vicarious learning is the role of the model who portrays the desired behavior to be learned.

Models in Vicarious Learning. Models, those who perform the *to be learned* behavior for the observer in vicarious learning, have been examined to see what factors make them effective. A model who initially depicts behaviors like indecision and errors, then moves towards self-confidence as they gradually improve their performance, have

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adopted a "coping" strategy. Research has shown models who adopt a "coping" strategy

have success in terms of impacting a learner's scores on posttests, increasing the self-

efficacy and training performance of a learner, as well as influencing a learners attitudes

about their own competency (Brassksma, Rihlaarsdam, & Huub van den Bergh, 2002;

Schunk, Hanson, & Cox, 1987). Models who appear similar to the learner, such as peers,

can increase a learner's self-efficacy by the logic, *"if they can do it I can do it too"*

(Schunk, Hanson, & Cox, 1987). Models can include humans, such as an older

individual acting as an instructor, a peer and more recently animated agents.

Animated Agents as Models. Animated agents are computer-generated

characters, ranging from non-human creatures to humanoids, designed to perform a

certain task (Johnson, Rickel, & Lester, 2000), and can easily be used as models within

vicarious learning (Craig et al., 2012). Because of the ease of manipulation, animated

agents have become a popular tool in multimedia learning environments, functioning as

learning companions, tutors and teachers. The perceived social connections between

human-to-human tutors and students can also be seen in using animated agents as

learning companions. Students working with animated agents often experience decreased

cognitive load, increases in active processing, motivation and a more pleasurable learning

experience (Moreno, Mayer, & Lester, 2000; Atkinson, Mayer, & Merrill, 2005; Lester &

Stone, 1997). Animated agents have been used to teach topics such as solving word

problems (Atkinson, 2002), helping skills (Adcock, Duggan, Nelson, & Nickel, 2006),

Newtonian physics, computer literacy (Craig et al., 2000) and critical thinking skills

(Graesser & McNamara, 2010).

However, while the manipulation of animated agents is fairly simple, creating an animated agent who is an efficient tutor requires the understanding of what the complex phenomenon of tutoring is and why it is effective. Once the concept of tutoring is understood the same models can be applied in examining what makes vicarious learning of tutoring effective.

Tutoring

Tutoring consists of a single instructor, the tutor, interacting with a single or small group of students, the tutee(s), to give more focused teaching (Roscoe & Chi, 2007). Tutoring is useful because the tutee can focus attention on a targeted concept until mastery occurs. Many theories have risen to explain why human tutoring is effective. One premise is a tutor can address the tutee's misconceptions and adjust their tutoring to tackle a specific problem until mastery occurs. During this process the student who is working with a tutor engages in most of the problem solving however is assisted by the tutor to steer away from deconstructive activities, which can lead to faulty learning. While the student is primarily involved in the problem solving, the tutor acts as mediator producing a *guided* learning by doing experience (VanLehn, 2011; Merril, Reiser, Ranney, & Trafton, 1992).

A tutor's social connection with the student provides the basis for many of the positive aspects incurred during tutoring. Tutors positively influence motivation in students by eliciting feelings of curiosity, challenge and control (Merril et al., 1992). Tutors have already learned the material in which they are teaching, yet often have not had formal training, so the tutor at times could be a student's peer (Chi, Siler, Jeong, Yamauchi, & Hausmann, 2001). The social interaction and cooperation of equal peer

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partners promotes cognitive restructuring and growth, and can help facilitate a more open and industrious exchange of ideas (Kim & Baylor, 2006; Driscoll, 2000).

The ability for tutoring to be useful across a wide range of topics begs the question: what makes tutoring effective? As previously stated, the perceived social connections between the tutor and tutee lend itself to many positive responses within the student's affect and learning process (Merril et al., 1992; Kim & Baylor, 2006; Driscoll, 2000). A very important effect of tutors and tutoring is that they positively influence motivation (Merril et al., 1992).

Goal Setting during Tutoring

Students play an important role in successful tutoring when they make the decision to seek help. The help-seeking process occurs in four steps: the student becomes aware of the need for help, the student then must decide whether or not to seek help, then identify potential helpers (such as tutors), and lastly strategize on how to obtain help (Vaessen, Prins, & Jeuring, 2014). The dialogue between the student and tutor then becomes crucial as conversational cues such as pauses can signal that the student does not understand the information. A tutor then can implement strategies such as reminding the student of the goal at hand or asking questions to promote the student to successfully overcome the impasse, a moment in learning where the student recognizes they do not understand a piece of knowledge (VanLehn, Siler, Murray, Yamauchi, & Baggett, 2003), and learn the targeted concept.

Within the domain of goal-setting two measures define a student's goal type. First, dimension or how a student perceives competence (for this matter we will focus on academic competence) is divided into mastery, sometimes referred to as learning goals,

and performance goals (Vaessen, Prins, & Jeuring, 2014). A student who adopts a learning goal (mastery goal) approach views learning as an opportunity to develop new skills; where a performance goal orientated individual will view the opportunity in a competitive way by trying to seek complimentary judgments and avoiding negative ones to validate their own competency and out-perform others, see Table 1 (Elliot & Church, 1997). The second factor is valence by which a student either wants to attain a desired outcome (approach goals) or avoid an undesirable outcome (avoidance goals). The combination of dimension and valence can help determine how the student will perceive and work through the learning opportunity.

Table 1.

Goal Orientations, Definitions and Example Behavior

Goal Orientation	Definition	Example Behavior
Learning Goal or Mastery Orientation	The development of competence and task mastery.	Choosing challenging course material in which they will learn new things.
Performance Goal Orientation	The demonstration of competence relevant to others.	
Performance Avoidance	Activity oriented towards the avoidance of failure	Avoiding asking questions or opportunities that may make them appear incompetent.
Performance Approach	Activity oriented toward the attainment of success	Viewing learning opportunities as a chance to out perform others.

* Elliot, A. J. & Church, M. A. (1997). A hierarchical model of approach and avoidance achievement motivation. *Journal of personality and social psychology*, *72*(1), 218.

Previous research has shown students working in an interactive learning environment compared to an in-person environment can lessen certain social stigmas that come with seeking help, such as threat to an individual's self-esteem, which can lead an individual to increase positive goal-setting strategies (Vaessen, Prins, & Jeuring, 2014). Goals within tutoring serve a distinct purpose of direction for the student and tutor.

Goals in tutoring are used as retrieval and selection cues for the principle(s) the learner should apply. The tutor produces goal-setting hints, such as asking questions, that help to focus the learner's attention and encourages the application of association with prior knowledge. If a goal-setting hint is not successful in correcting the action of the

student, it can be used as a stepping off point for a discussion of the principle. This discussion will likely increase the probability of the student learning the targeted principle (VanLehn et al., 2003). In a more general application, goals influence self-monitoring and judgments of performance attainment. This increases a student's cognitive and affective reaction to performance outcomes by specifying the requirements for personal success (Zimmerman, Bandura, & Martinez-Pons, 1992). As previously mentioned, vicarious learning and learning with peers have been shown to have positive influences on learning much through the student's empathetic ability.

Learners may draw positive judgments about their capabilities when they observe animated agents (computer-generated life-like characters who can serve as virtual learning companions) who demonstrate successful performance (Lester, Convers, Stone, Kahler, & Barlow, 1997; Baylor & Kim, 2005). Students working with an agent produced more conceptually accurate solutions on practice problems and perceived worked out examples to be less difficult (Atkinson, 2002). From prior research with related topics it appears agents may be able to effectively influence goal setting as well as the instruction of the topic of goal setting.

If we are able to control goal setting information in a vicarious learning environment to present accurate and appropriate goal setting techniques to a novel topic such as the physics concept of rotational kinematics, we should be able to observe a student viewer not only learning the information about physics but also possibly being influenced by the agent's goal setting technique.

Hypotheses

Vicarious learning from tutoring is an effective method of teaching skills and knowledge to individuals by modeling desired behaviors. Models encourage factors beyond the immediate learning object such as increased self-efficacy and positive thoughts of self by the learner. While models have been shown to successfully teach various topics it has yet to be examined if a secondary behavior can be vicariously influenced, such as goal orientation. To examine this, the following hypotheses were established for the current study.

Hypothesis 1. Goal setting is an important behavior to learn due to the positive nature it has on learning including guiding self-monitoring and judgments of performance attainment which constructively effects the cognitive and affective reactions in learners by specifying the requirements for personal success (Zimmerman, Bandura, & Martinez-Pons, 1992). Because models have been shown to guide desired behvaior, it was hypothesized that having learners observe a tutoring session guided by good goal setting strategies would improve learning. For the presented study it was predicted, participants would retain more information when a tutoring session with explicit goal setting was observed.

Hypothesis 2. Research has shown models can influence many factors from behavior (Bandura, Ross & Ross, 1963; Halpern, Millis, Graesser, Butler, Forsyth, & Cai, 2012) to performance and self-perception (Schunk, Hanson, & Cox, 1987), as well as academic skills such as question asking (Craig et al., 2000). Due to these findings, it was hypothesized that having learners observe a tutoring session guided by a model demonstrating good goal setting strategies would influence the learners personal goal

orientation. It was predicted a participant who previously showed performance

avoidance goal orientation would present shifts towards learning goal orientation after

viewing a successful implementation of learning goal setting techniques.

CHAPTER 2

METHOD

Participants

To estimate the number of participants needed to find possible significant results a power analysis was conducted through G-Power. A power analysis assuming a moderate effect size of $\rho^2 = 0.20$ with power of 0.95 would require a total $n = 95$ participants to find an effect, $\alpha < 0.05$. Taking into consideration possible outliers and un-useable data the sample size was increased to 130.

A total of 136 participants were collected through Amazon Mechanical Turk. Reports have indicated approximately forty-seven percent of M-Turk users are American with the majority being female (64.85%) versus male (35.15%) and the average age of a user is thirty-six years old (Paolacci, Chandler, & Ipeirotis, 2010). For the current study only participants from the United States of America were used. According to self-reports collected by Paolacci et al., (2010) the educational level of a Mechanical Turk user is above that of the general U.S. population. To ensure quality workers are recruited the present study used M-Turkers with a hit approval rate of 90% or higher.

Demographic information showed 71 participants self-identified as female while 59 identified as male. The majority of participants identified as being between the ages of 26-34 years old and the average education level was "some college". From the sample, 50 participants indicated they had previously taken a physics course while the remaining 86 participants indicated they had not taken any physics courses or classes.

Design and Materials

Design. The study used a randomized pretest-posttest design with a control condition. The pretest included an Achievement Goals Questionnaire (AGQ) survey and a multiple choice physics knowledge retention test. The AGQ measured Learning Goal Orientation (LGO), which was determined by the responses to six statements that included words and phrases which reflect LGO ideology such as, "a desire to master", preference of learning material that "arouses curiosity" or is new and challenging (Appendix C). Additionally, the AGQ survey evaluated Performance Avoidance Goal Orientation (PAVGO) using six statements that convey emotions such as doubt and fear of performing poorly as well as avoiding appearing incompetent (Appendix C). Posttests included the AGQ and a counterbalanced version of the multiple choice physics retention test.

The physics knowledge retention test measured rotational kinematics, the branch of physics that studies objects in a rotating motion, knowledge by correct responses to twelve multiple-choice questions (Craig, Chi & Van Lehn, 2009).

The randomized conditions included a control level, in which a multimedia presentation of a physics tutoring session with the absence of goal setting dialogue was shown, and an experimental level, which showed a physics tutoring session with added goal orientation dialogue. To assess learning gains scores from the pre and posttest were compared. Any shifts from performance goal orientation to learning goal orientation reported by participants within each of the conditions were measured using the Achievement Goals Questionnaire (AGQ).

Conditions. The multimedia learning presentations took approximately 10 minutes.   The experimental condition included a multimedia presentation in which a physics based tutoring session between two virtual agents was shown (See Appendix F). Within this condition, the dialogue was modified to contain verbal techniques to possibly induce goal oriented behavior. Approximately 30 learning goal oriented statements were spoken by the student. The control condition showed the same multimedia tutoring session however the dialogue was not modified to include goal oriented dialogue (See Appendix G).

Physics Dialogue. The dialogue used was adapted from Craig, Chi, and VanLehn's 2009 study. The dialogue was between a retired doctoral physics professor, acting as the tutor, and a student with intermediate-level physics knowledge (Craig, et al., 2009). The tutoring session had the student solving a rotational kinematics problem using the Andes tutoring system with the help of the expert tutor (Craig, et al., 2009). The existing study used dialogue from the physics problems covering concepts of rotational kinematics problems (Craig, et al., 2009).

Control Condition. The control condition implemented dialogue from two rotational kinematics tutoring problems from the Craig et al., 2009 study. The dialogue did not contain wording that influenced or assisted in the implementation of goal setting. The dialogue strictly focused on how to solve the two physics problem (Appendix G).

Experimental Condition. The experimental condition used the same dialogue from the rotational kinematics tutoring session however was modified by inserting dialogue demonstrating learning goal orientation strategies. Such strategies included the student modeling goal setting behavior: such as asking the tutor questions, which elicits

prior knowledge of the material, or stating their overall goal to the tutor. This dialogue

included statements of importance of procedure, knowledge, importance and application,

as well as affect and challenge/motivation (See Table 2). The tutor only used exercises

such as prompting or hinting when the student reaches an impasse (See Appendix F).

Table 2.

Learning Goal Oriented Strategies embeded in Experimental Script

Categories	General Statements	Applied Examples
Need to increase knowledge	I need to learn "x"	I need to learn rotational kinematics.
Need to increase procedure	I need to learn how to use "x" to solve for "y".	I need to learn the steps
Need to increase importance	"X" is important to me because…	It is important for me to learn rotational kinematics because it increases my knowledge of physical bodies in motion.
Need to increase application	I can use my knowledge of "x" for …	I need to know how to apply my knowledge of rotational kinematics to solve problems such as determining stopping time of a body in motion such as a wheel.
Affect	The understanding of "x" is important to me because I want …	Because I have learned about the basic laws of physics I am know interested in learning about rotational kinematics. I am confused about aspects of rotational kinematics because it is more complex than I expected.
Challenge/Motivation	It is important to be challenged by things such as "x"…	It is okay to be challenged by material such as rotational kinematics because it is apart of the learning process.

Multimedia Learning Environment. The multimedia presentations were created

using MediaSemantics Character Builder. Two virtual humans were selected from the

existing library to act as tutor and tutee. Their dialogue came from scripts typed into the

software. Information from the video presentations in Craig, et al., (2009) was inserted

into the white board within the background of the multimedia environment to act as

visual aids during the tutoring session. Once the two multimedia presentations were

created they were saved and uploaded into Qualtrics. Within Qualtrics a rule was entered

to randomize the presentations.

Figure 1. Screenshot of multimedia learning presentation.

Demographic Survey. All participants were be asked to complete a demographic

survey containing eleven questions regarding their age, gender, education level, and

current employment (See Appendix A).

Physics Knowledge Retention. Two twelve item multiple choice tests were used

to measure conceptual knowledge of rotational kinematics (Craig, et al., 2009). Each

question had four possible answers. The isomorphic multiple-choice tests contained the

same information however were counterbalanced to prevent order effects (See Appendix

D and E). An example isomorphic item from the multiple choice tests include, "A top

with a positive z component of angular velocity (ω) would be spinning in which

direction?" and "A top with a z component angular velocity (**ω**) that was negative would be spinning in which direction?" Qualtrics randomly assigned one version as the pre-test and one version as the posttest.

      Goal Orientation. Goal orientation was measured using a modified version of Elliot and Church's (1997) Achievement Goals Questionnaire (AGQ) (Appendix B). This twelve-item questionnaire used a 1 (strongly disagree) to 7 (strongly agree) Likert scale to measure mastery (α=.89) and performance-avoidance (α=.77) goal tendencies (Elliot & Church, 1997). Performance approach items were removed due to previous research, which closely links performance approach, and mastery goal orientation together as they both entail the individual to strive for positive outcomes (Elliot & Harackiewicz, 1994). The wording of the statements were changed to reflect the study and not a particular course or class. In example, a statement from Elliot and Church's (1997) original questionnaire stated, "I just want to avoid doing poorly in this class" however in the current study the statement has been changed to "I just wanted to avoid doing poorly in this activity". Additionally, the wording was change to reflect future and past test in the pretest and posttest, respectively. Comparing scores on the AGQ measured any shifts in the participant's goal orientation.

      Learning Goal Orientation (LGO). Six items reflected the participants learning goal orientation by asking them to rate how strongly they agreed or disagreed to a statement such as, " I prefer course material that really challenges me so I can learn new things."

      Performance Avoidance Orientation (PAVGO). To measure performance-avoidance beliefs the questionnaire listed six statements to which they rated their

response such as, "I just wanted to avoid doing poorly in this activity." See Appendix B for the complete questionnaire and Appendix C for a breakdown of the type of orientation each statement represented.

Agent Persona Instrument. The agent persona instrument is a twenty-five-item questionnaire scored using a five-item likert scale (1 = strongly disagree, 3= neutral, 5=strong agree) measuring a participant's perception of an agent (Ryu & Baylor, 2005). The API measures facilitation of learning, credibility, level to which the agent is perceived as human like and the agent's credibility. These have been shown to increase the perception of a person-like persona (Baylor & Ryu, 2003). See Appendix I.

Procedure

Participants were recruited through Amazon's Mechanical Turk. Once accepting the hit participants were redirected to Qualtrics to complete the study. Qualtrics randomly assigned the participant into either the experimental or control condition. They read a consent form and if they agreed to participate were asked to select a box stating they have read the information and agreed to participate in the study. They then proceeded to a demographic questionnaire, an Achievement Goal Questionnaire pretest and a multiple choice physics pretest. Once the questionnaires were completed the students were asked to perform a sound check ensuring they could hear the audio in the presentation. They then viewed a multimedia presentation created using Media Semantics Character Builder in which a tutor and tutee worked together to solve a rotational kinematics problem and was approximately 10 minutes in length. In the experimental condition the tutee/tutor employed mastery goal-setting strategies to help the student solve the problem. In the control condition the elements of goal setting were removed. After viewing the

presentation the participants again completed a series of questionnaires. First, the Achievement Goals Questionnaire was completed as a posttest. They then completed the isomorphic multiple-choice posttest. Finally, they completed the Agent Persona Instrument. Once finished the participants were given a completion code. They then were redirected to Mechanical Turk and inserted the completion code which signaled to the experimenter they had successfully completed the experiment. Participants were awarded payment into their Mechanical Turk workers account.

Scoring

Goal Orientation. Goal orientation was scored using Elliot and Church's (1997) Achievement Goal Questionnaire (AGQ). To measure goal orientation, the reported scores of PAVGO and LGO were averaged separately then each factor was analyzed. For example if a participant responded "3,4,2,1,2,3" for the learning goal orientation and "7,3,6,7,5,4" for performance goal orientation on the pre-test, their average LGO score would be 2.5 on a scale of 1-7 and their PAVGO score would be 5.3 on a scale of 1-7. It was thought after viewing the experimental condition those who ranked low (below 4) on the LGO score would increase shifting above an average score of 4 or those who ranked high on PAVGO, on the posttest their scores would decline below 4. The total number from the pretest was compared to the posttest scores to examine shifts in orientation. (Appendix C).

Physics Knowledge. Physics knowledge was scored using material from Craig, Chi, & Van Lehn's 2009 study. For the multiple choice retention test participants received one point for each correct answer.

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Analysis

      The current analysis examined results of 136 participants to determine if viewing a physics tutoring presentation in which goal-oriented dialogue was inserted influenced learning outcomes and goal orientation. To examine if the predictor variables of physics pretest score (also a covariate), the two subscales of the AGQ (Learning Goal Orientation and Performance Avoidance Goal Orientation), randomized condition as well as two interaction terms of the participant's scores on the two AGQ subscales and condition significantly predicted learning, a hierarchal linear regression model was conducted. Repeated measures t-tests were used to examine shifts from PAVGO to LGO.

RESULTS

Predicting Physics Knowledge Acquisition

A hierarchical liner regression was performed on participant's observed learning scores at posttest using their physics pretest score, the two subscales of the AGQ (Performance Goal Orientation and Learning Goal Orientation), randomized condition as well as two interaction terms of the participant's scores on the two AGQ subscales and condition as predictor variables. Results examining the predictive relationship between a participant' physics pretest score and physics post test score indicated a significant regression model, $F(1,134) = 53.380, p < .001, R^2 = .285$, (See Table 4). The analysis of the influence of goal orientation on learning yield non-significant results. However, the larger model with physics pretest, LGO pretest, PAVGO pretest and condition was significant, $F(4,131) = 14.297, p < .001, R^2 = .019$ (See Table 4). Examination of the predictor variables individually showed the physics pretest scores significantly influenced the model, $t(1,134) = 7.129, \beta = .521, p < .001$. No other predictor variable alone significantly predicted physics post-test scores. Furthermore, the addition of the interaction terms of LGO and condition, $t(1,134) = -.580, p = .563, \beta = -.111$, as well as PAVGO and condition, $t(1,134) = -.052, p = .958, \beta = .028$ were non-significant as individual predictors.

Table 3.

Pre and Post Test Scores by Condition

Predictor Variable	Control		Experimental	
	M	*SD*	*M*	*SD*
Physics Pretest Score	3.821	2.153	3.870	1.992
Physics Post Test Score	4.179	2.052	4.275	1.992
LGO Pretest Score	5.946	.772	6.066	.803
LGO Post Test Score	5.545	1.036	5.411	1.092
PAVGO Pretest Score	3.918	1.280	3.840	1.447
PAVGO Post Test Score	4.281	2.080	4.078	1.458

Table 4.

Hierarchical Linear Regression Model Predicting Physics Posttest Scores

Model	β	ΔR^2	*Significance*
Step 1	2.226	.285	(7.160, .000)**
Physics Pretest Score	.521		(7.306, .000)**
Step 2	3.473	.019	(2.699, .008)*
LGO Pretest Score	-.070		(-.368, .714)
PAVGO Pretest Score	-.204		(-1.871, .064)
Condition	-.032		(-.218, .828)
Step 3	3.483	.002	(2.688, .008)*
LGOxCondition	-.111		(-.580, .563)
PAVGOxCondition	.028		(.253, .800)

Notes: Dependent Variable: Physics Posttest Score
* $p < .05$
** $p < .001$

Predicting Learning Goal Orientation

Next, learning goal orientation (LGO) post-test scores were examined. Results from the hierarchal linear regression model indicated physics pre-test scores did not significantly predict LGO post-test scores, $F(1,134) = .005, p = .945, R^2 = .000$. The model of physics pretest, performance avoidance goal orientation (PAVGO) pretest, LGO pretest and condition was significant, $F(4,131) = 28.542, p < .001, R^2 = .466$ (See Table 5). Further investigation of the predictor variables alone showed LGO pre-test scores

significantly influenced the model, $t(1,134) = 10.538, p < .001, \beta = .950$, which was to be

expected. No other predictor variable alone significantly predicted LGO post-test scores.

The addition of the interaction terms of LGO and condition, $t(1,134) = 1.002, p = .318, \beta$

$= .091$, as well as PAVGO and condition, $t(1,134) = .645, p = .520, \beta = .034$, were non-

significant as individual predictors.

Table 5.

Hierarchical Linear Regression Model Predicting LGO Posttest Scores

Model	β	ΔR^2	*Significance*
Step 1	5.467	.000	(27.371, .000)**
Physics Pretest Score	.003		(.069, .945)
Step 2	-.019	.466	(-.031, .975)
LGO Pretest Score	.950		(10.538, .000)**
PAVGO Pretest Score	-.022		(-.433, .666)
Condition	.078		(1.112, .268)
Step 3	-.001	.005	(-.002, .998)
LGOxCondition	.091		(1.002, .318)
PAVGOxCondition	.034		(.645, .520)

Notes: Dependent Variable: LGO Posttest Score
* $p < .05$
** $p < .001$

Predicting Performance Avoidance Goal Orientation

The hierarchal linear regression model examining performance avoidance goal

orientation post-test scores as a dependent variable indicated a significant negative

correlation between physics pre-test scores and PAVGO post-test scores, $F(1,134) =$

$4.790, p < .05, R^2 = .035, \beta = -.130$. This indicates participants with higher scores on the

physics pretest scored lower on their subsequent PAVGO post-test. The model of physics

pretest, performance avoidance goal orientation (PAVGO) pretest, LGO pretest and

condition was also significant, $F(4,131) = 47.922, p < .001, R^2 = .594$ (See Table 6).

Examination of the predictor variables individually showed PAVGO pretest scores were

significant, $t(1,134) = 13.318, p < .001, \beta = .799$. LGO pretest scores were also

significant predictor of PAVGO posttest scores, $t(1,134) = 2.843, p < .05, \beta = .296$.

Additionally, physics pretest scores were significant within the model, $t(1,134) = -2.353$,

$p < .05, \beta = .-.093$ Furthermore, the addition of the interaction terms of LGO and

condition, $t(1,134) = .600, p = .549, \beta = .063$, as well as PAVGO and condition, $t(1,134)$

$= .516, p = .607, \beta = .031$, were non-significant as individual predictors.

Table 6.

Hierarchical Linear Regression Model Predicting PAVGO Posttest Scores

Model	β	ΔR^2	Significance
Step 1	4.638	.035	(17.836, .000)**
Physics Pretest Score	-.130		(-2.189, .030)*
Step 2	-.381	.560	(-.539, .591)
LGO Pretest Score	.296		(2.843, .005)*
PAVGO Pretest Score	.799		(13.318, 000)**
Condition	.093		(1.153, .251)
Step 3	-.366	.002	(-.514, .608)
LGOxCondition	.063		(.600, .549)
PAVGOxCondition	.031		(.516, .607)

Notes: Dependent Variable: PAVGO Posttest Score
* $p < .05$
** $p < .001$

Learning Goal Orientation

Repeated measures t-tests were performed to compare the participants' score on

the AGQ pretest to their score on the AGQ post-test (See Table 3). There were

significant gains from LGO pretest to posttest observed in both the control, $t(66) = 4.750$,

$p < .05, d = .531$ and experimental conditions, $t(68) = 5.982, p < .05 \ d = .572$.

Performance Avoidance Goal Orientation

PAVGO scores significantly changed from pretest to posttest in the control condition, $t(66) = -2.674, p < .05, d = .241$. However, participants in the experimental condition in which goal oriented dialogue was included did not experience a significant change in their PAVGO scores from pre to post test, $t(68) = -1.542, p > .05, d = .130$. While these individuals did not experience gains in LGO their PAVGO scores did not significantly shift where as those in the control condition reported higher PAVGO scores in their post-test than their pre test.

Agent Persona Instrument

An independent sample t-test concluded there were no significant differences between conditions in participant's perceptions of the agents' personas including their ability to facilitate learning, their credibility, if they were human-like and if they were engaging. See Table 7.

Table 7.

API by Condition

	Control		Experimental	
Factor	*M*	*SD*	*M*	*SD*
Facilitate Learning	2.835	1.037	2.834	1.061
Credible	3.625	.901	3.620	.811
Human-like	2.282	1.045	2.403	.877
Engaging	2.664	.980	2.630	.823

Chapter 5

DISCUSSION

The current study aimed to examine if the addition of proper goal-setting dialogue to an educational presentation of rotational kinematics would influence previous goal orientation and learning. It was hypothesized participants who rated as performance avoidance goal orientated would shift towards a learning goal orientation if randomized into the experimental condition in which goal orientated dialogue was provided. It was also hypothesized viewing a tutoring session with integrated goal-setting dialogue would increase learning of the subject matter.

The observed participant's data only provided mild support for the predictions. Results indicated learning goal orientation (LGO) was not significantly effected in a positive direction by observing the experimental dialogue. However, there was partial support of the second hypothesis. Performance avoidance goal orientation (PAVGO) did not significantly change compared to those who did not receive goal oriented dialogue in which their subsequent PAVGO scores increased on the post-test.

Physics Learning Environment

One possible explanation for these findings is the learning environment used in the current study was extremely challenging. A 2008 survey showed among the factors inherent to physics, students, teaching assistants and faculty stated the cumulative aspect of physics is challenging in that concepts build upon each other therefore if one piece of knowledge is missing or miss learned it impacts subsequent learning (Ornek, Robinson & Haugan, 2008). These findings could support the observation of LGO pretest scores presenting as a significant predictor of PAVGO such that when those who scored higher

on the LGO pretest increased in their PAVGO posttest scores. The challenging nature of physics could have negatively impacted their perception of their own abilities.

Physics and Learning Goal Orientation

The predicted shifts towards LGO failed to be observed and decreased across conditions. The physics learning environment could provide an explanation of these findings. Previous research indicates the positive effects of goal setting on performance are not observed in novel or complex tasks, providing support for the current findings regarding LGO scores (LePine, 2005). In addition to the physics content, the gender of the models in the current multi-media learning environment could have negatively impacted the females in the sample.

Physics and Gender

It should be noted the utilized learning domain of physics could have negatively impacted the female participant's goal orientation. Examining gender differences in the sciences: biology, chemistry, mathematics and physics, only 22% of physic bachelor's degrees received were by women, exemplifying the predomination of males in the field (Hazari, Tai, & Sadler, 2007). Past research indicates females tend to hold negative perceptions about their abilities even when performing better than males in a science class (Jones, Howe, & Rua, 2000). Such factors present the need for future research to examine if the gender of virtual humans can influence learning and goal orientation among participants, particularly females.

Learner Gender and Model Gender

Previous research has shown the self-efficacy of a learner tends to increase when viewing a model who appears similar to them. Prior findings indicate similarity-attraction

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effects, in which people are more attracted to others who are more similar to themselves, including increased interaction and attention have been shown to present in human-computer interactions (Moreno & Flowerday, 2006). As mentioned coping-strategies positively influence a learner's posttest scores, self-efficacy, training performance and attitudes about their own competency (Brassksma et al., 2002; Schunk et al., 1987). Within the current study the tutee, also the one providing the physics information and goal-oriented content, was a male agent. If the gender roles had been reversed possible changes in the female posttest orientation scores may have been observed given females represented 64.85% of the sample. To explore the impact of gender on personal goal orientation change and learning within the presented physics environment the gender of the virtual humans should be manipulated. Future studies should explore the use of a male tutor with a female tutee, female tutor and male tutee and lastly same gender tutor and tutee within the multimedia-learning environment. In addition to gender other demographic information such as age should be taken into consideration.

Age and Goal-Orientation

Within the current study positive shifts within the selected goal orientations were not observed. The age range of the participants may help to explain these findings. Ebner, Freund, and Bates (2006) examined age in relation to personal goal orientation and found evidence linking that middle age (40-59 years old) and older (65-84 years old) adults primarily were concerned with maintenance and prevention loss while younger (18-26 years old) were oriented towards growth. Participants who fell within the age group of 18-25 years old represented only 21.3% of the sample. Due to the large amount (78.7%) of the sample who identified outside of the 18-25 age group may have

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influenced the results because they are set in their goal orientation and are seeking to maintain and prevent loss of their orientation.

Length of Exposure to the Learning Environment

Additionally, the length of the study and exposure to the experimental dialogue should be taken into consideration. Previous research multimedia based vicarious learning has had videos that ranged from 22 minutes in length (Craig et al., 2009), 35 minutes (Craig, Sullins, Witherspoon, & Gholson, 2006) or around 12 minutes each day for 7 days (Craig, et al., 2012). The observational videos in the current study were approximately 10 minutes long and were only viewed once. This may not have been enough of a dosage to create an effect. A longitudinal study utilizing repeated exposure to the experimental dialogue condition may serve as a more appropriate design than only having the participants view the presentation once.

Conclusion

Kirkpatrick's Four-Level Training Evaluation Model was used to address reactions, learning, behavior, and results (Kirkpatrick, 2009). However, it should be noted that results as explained by Kirkpatrick's Model cannot be directly applied to the current study; instead a more theoretical framework of potential implications of the results are discussed.

Reactions. Findings from the current study show that of the four factors presented by the Agent Persona Instrument across conditions participants rated credibility highest. This finding gives support that agents do present as helpful instructors. However, the effectiveness of the training in terms of participants reported reaction was not impacted by the addition of goal-oriented statements.

Learning. Prior research has shown vicarious learning with virtual humans effects knowledge acquisition by decreasing cognitive load, increasing active processing and creating a more enjoyable learning experience (Moreno et al., 2000; Atkinson et al., 2005; Lester & Stone, 1997) in a number of learning contexts including solving word problems (Atkinson, 2002), helping skills (Adcock et al., 2006) computer literacy and critical thinking skills (Graesser, Lu, Jackson, Mitchell, Ventura, Olney, & Louwerse, 2004). The current study showed significant learning gains from the pre to post physics retention test thus supporting agents as effective tutors.

Behavior. Self-report findings from the current study did show that PAVGO did not significantly change in the experimental condition showing that some form of behavioral change is possible. However, it cannot be concluded such self-report findings would transfer into actual behavior.

The current study provided support that the addition of proper goal setting dialogue to an educational presentation can influence goal-orientation by preventing performance-avoidance goal orientation increase. Implications of the presented study provide a potential method of discouraging the adoption of poor goal-setting behavior if proper goal-setting dialogue is included in tutoring. If this finding holds, then it could be useful for helping students learn new and difficult information and from setting purely performance-avoidance goals which could hinder future learning or willingness to continue.

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REFERENCES

Adcock, A. B., Duggan, M. H., Nelson, E., & Nickel, C. (2006). Teaching effective helping skills at a distance: The development of project CATHIE. *Quarterly Review of Distance Education*, 7(4), 349-360.

Atkinson, R. K. (2002). Optimizing learning from examples using animated pedagogical agents. *Journal of Educational Psychology*, *94*(2), 416.

Atkinson, R. K., Mayer, R. E., & Merrill, M. M. (2005). Fostering social agency in multimedia learning: Examining the impact of an animated agent's voice. Contemporary Educational Psychology, 30(1), 117-139.

Bandura, A. (1965). Vicarious processes: A case of no-trial learning. *Advances in experimental social psychology*, *2*, 1-55.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Bandura, A., Ross, D., & Ross, S. A. (1963). Imitation of film-mediated aggressive models. *The Journal of Abnormal and Social Psychology*, *66*(1), 3.

Baylor, A. L., & Kim, Y. (2005). Simulating instructional roles through pedagogical agents. *International Journal of Artificial Intelligence in Education*, *15*(2), 95-115.

Baylor, A., & Ryu, J. (2003). The API (Agent Persona Instrument) for assessing pedagogical agent persona. In *World Conference on Educational Multimedia*, *Hypermedia and Telecommunications* (Vol. 2003, No. 1, pp. 448-451).

Braaksma, M. A., Rijlaarsdam, G., & Van den Bergh, H. (2002). Observational learning and the effects of model-observer similarity. *Journal of Educational Psychology*, *94*(2), 405.

Chi, M. T., Roy, M., & Hausmann, R. G. (2008). Observing tutorial dialogues collaboratively: Insights about human tutoring effectiveness from vicarious learning. *Cognitive Science, 32(2)*, 301-341.

Chi, M. T., Siler, S. A., Jeong, H., Yamauchi, T., & Hausmann, R. G. (2001). Learning from human tutoring. *Cognitive Science*, *25*(4), 471-533.

Cox, R., McKendree, J., Tobin, R., Lee, J., & Mayes, T. (1999). Vicarious learning from dialogue and discourse. *Instructional science, 27(6)*, 431-458.

Craig, S. D., Chi, M. T., & VanLehn, K. (2009). Improving classroom learning by collaboratively observing human tutoring videos while problem solving. *Journal of Educational Psychology*, *101*(4), 779.

Craig, S. D., Gholson, B., Brittingham, J. K., Williams, J. L., & Shubeck, K. T. (2012). Promoting vicarious learning of physics using deep questions with explanations. *Computers & Education*, *58*(4), 1042-1048.

Craig, S. D., Gholson, B., Ventura, M., & Graesser, A. C. & Tutoring Research Group. (2000). Overhearing dialogues and monologues in virtual tutoring sessions: Effects on questioning and vicarious learning. *International Journal of Artificial Intelligence in Education*, *11*, 242-253.

Craig, S. D., Sullins, J., Witherspoon, A., & Gholson, B. (2006). The deep-level-reasoning-question effect: The role of dialogue and deep-level-reasoning questions during vicarious learning. *Cognition and Instruction*, *24*(4), 565-591.

Driscoll, M. P. (2000). *Psychology of learning for instruction.* Boston, MA: Allyn & Bacon.

Driscoll, D. M., Craig, S. D., Gholson, B., Ventura, M., Hu, X., & Graesser, A. C. (2003). Vicarious learning: Effects of overhearing dialog and monologue-like discourse in a virtual tutoring session. *Journal of Educational Computing Research*, *29*(4), 431-450.

Ebner, N. C., Freund, A. M., & Baltes, P. B. (2006). Developmental changes in personal goal orientation from young to late adulthood: from striving for gains to maintenance and prevention of losses. *Psychology and aging*, *21*(4), 664-678.

Elliot, A. J., & Harackiewicz, J. M. (1994). Goal setting, achievement orientation, and intrinsic motivation: A mediational analysis. *Journal of personality and social psychology, 66(5)*, 968.

Elliot, A. J., & Church, M. A. (1997). A hierarchical model of approach and avoidance achievement motivation. *Journal of personality and social psychology*, *72*(1), 218.

Gholson, B., & Craig, S. D. (2006). Promoting constructive activities that support vicarious learning during computer-based instruction. *Educational Psychology Review*, *18*(2), 119-139.

Graesser, A. C., Lu, S., Jackson, G. T., Mitchell, H. H., Ventura, M., Olney, A., & Louwerse, M. M. (2004). AutoTutor: A tutor with dialogue in natural language. *Behavior Research Methods, Instruments, & Computers, 36(2)*, 180-192.

Graesser, A., & McNamara, D. (2010). Self-regulated learning in learning environments with pedagogical agents that interact in natural language. *Educational Psychologist*, *45*(4), 234-244.

Halpern, D. F., Millis, K., Graesser, A. C., Butler, H., Forsyth, C., & Cai, Z. (2012). Operation ARA: A computerized learning game that teaches critical thinking and scientific reasoning. *Thinking Skills and Creativity*, *7*(2), 93-100.

Hazari, Z., Tai, R. H., & Sadler, P. M. (2007). Gender differences in introductory university physics performance: The influence of high school physics preparation and affective factors. *Science Education*, *91*(6), 847-876.

Johnson, W. L., Rickel, J. W., & Lester, J. C. (2000). Animated pedagogical agents: Face-to-face interaction in interactive learning environments. *International Journal of Artificial intelligence in education*, *11*(1), 47-78.

Jones, M. G., Howe, A., & Rua, M. J. (2000). Gender differences in students' experiences, interests, and attitudes toward science and scientists. *Science Education*, *84*(2), 180-192.

Kim, Y., & Baylor, A. L. (2006). A social-cognitive framework for pedagogical agents as learning companions. *Educational Technology Research and Development, 54(6)*, 569-596.

Kirkpatrick, D. L. (2009). *Implementing the Four Levels: A Practical Guide for Effective Evaluation of Training Programs: Easyread Super Large 24pt Edition*. ReadHowYouWant. com.

LePine, J. A. (2005). Adaptation of teams in response to unforeseen change: effects of goal difficulty and team composition in terms of cognitive ability and goal orientation. *Journal of Applied Psychology*, *90*(6), 1153.

Lester, J. C., Converse, S. A., Kahler, S. E., Barlow, S. T., Stone, B. A., & Bhogal, R. S. (1997, March). The persona effect: affective impact of animated pedagogical agents. In *Proceedings of the ACM SIGCHI Conference on Human factors in computing systems* (pp. 359-366). ACM.

Lester, J. C., & Stone, B. A. (1997, February). Increasing believability in animated pedagogical agents. In *Proceedings of the first international conference on Autonomous agents* (pp. 16-21). ACM.

Merrill, D. C., Reiser, B. J., Ranney, M., & Trafton, J. G. (1992). Effective tutoring techniques: A comparison of human tutors and intelligent tutoring systems. *The Journal of the Learning Sciences, 2(3)*, 277-305.

Moreno, R., & Flowerday, T. (2006). Students' choice of animated pedagogical agents in science learning: A test of the similarity-attraction hypothesis on gender and ethnicity. *Contemporary Educational Psychology*, *31*(2), 186-207.

Moreno, R., Mayer, R., & Lester, J. (2000). Life-like pedagogical agents in constructivist multimedia environments: Cognitive consequences of their interaction. In *World Conference on Educational Multimedia, Hypermedia and Telecommunications* (Vol. 2000, No. 1, pp. 776-781).

Ornek, F., Robinson, W. R., & Haugan, M. P. (2008). What Makes Physics Difficult?. *International Journal of Environmental and Science Education*, *3*(1), 30-34.

Paolacci, G., Chandler, J., & Ipeirotis, P. (2010). Running experiments on amazon mechanical turk. *Judgment and Decision Making*, *5*(5), 411-419.

Pekrun, R., Elliot, A. J., & Maier, M. A. (2006). Achievement goals and discrete achievement emotions: A theoretical model and prospective test. *Journal of Educational Psychology*, *98*(3), 583.

Rogoff, B., Paradise, R., Arauz, R. M., Correa-Chavez, M., & Angelillo, C. (2003). Firsthand learning through intent participation. *Annual review of psychology*, *54*(1), 175-203.

Roscoe, R. D., & Chi, M. T. (2007). Understanding tutor learning: Knowledge-building and knowledge-telling in peer tutors' explanations and questions. *Review of Educational Research*, *77*(4), 534-574.

Rummel, N., & Spada, H. (2005). Learning to collaborate: An instructional approach to promoting collaborative problem solving in computer-mediated settings. *The Journal of the Learning Sciences*, *14*(2), 201-241.

Ryu, J. E. E. H. E. O. N., & Baylor, A. L. (2005). The psychometric structure of pedagogical agent persona. *Technology Instruction Cognition And Learning*, 2(4), 291-314.

Schunk, D. H., Hanson, A. R., & Cox, P. D. (1987). Peer-model attributes and children's achievement behaviors. *Journal of Educational Psychology*, *79*(1), 54.

VandeWalle, D., Brown, S. P., Cron, W. L., & Slocum Jr, J. W. (1999). The influence of goal orientation and self-regulation tactics on sales performance: A longitudinal field test. *Journal of Applied Psychology*, *84*(2), 249.

VanLehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. *Educational Psychologist*, *46*(4), 197-221.

VanLehn, K., Siler, S., Murray, C., Yamauchi, T., & Baggett, W. B. (2003). Why do only some events cause learning during human tutoring?. *Cognition and Instruction*, *21*(3), 209-249.

Vaessen, B. E., Prins, F. J., & Jeuring, J. (2014). University students' achievement goals and help-seeking strategies in an intelligent tutoring system. *Computers & Education*, *72*, 196-208.

Zimmerman, B. J., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American educational research journal, 29(3)*, 663-676.

APPENDIX A

DEMOGRAPHIC QUESTIONNAIRE

Are you a US citizen?
- Yes
- No

What is your primary language (i.e., the one you speak most of the time)?
- English
- Spanish
- Chinese
- French
- German
- Dutch
- Japanese
- Hebrew
- Swedish
- Other (specify) _____

What is your gender?
- Male
- Female

Please indicate the highest level of education completed.
- Grammar School
- High School or equivalent
- Vocational/Technical School (2 year)
- Some College
- College Graduate (4 year)
- Master's Degree (MS)
- Doctoral Degree (PhD)
- Professional Degree (MD, JD, etc.)
- Other

What is your current marital status?
- Rather not say
- Divorced
- Living with another
- Married
- Separated
- Single
- Widowed

How old are you?
- Under 13
- 13-17
- 18-25
- 26-34
- 35-54
- 55-64
- 65 or over _____

 Which of the following categories best describes the industry you primarily work in?
- Agriculture, Forestry, Fishing and Hunting
- Utilities
- Computer and Electronics Manufacturing
- Wholesale
- Transportation and Warehousing
- Software
- Broadcasting
- Real Estate, Rental and Leasing
- Primary/Secondary (K-12) Education
- Health Care and Social Assistance
- Hotel and Food Services
- Legal Services
- Homemaker
- Religious
- Mining
- Construction
- Retail
- Publishing
- Telecommunications
- Information Services and Data Processing
- Finance and Insurance

- College, University, and Adult Education
- Arts, Entertainment, and Recreation
- Government and Public Administration
- Scientific or Technical Services
- Military
- Trained Professional
- Skilled Laborer
- Consultant
- Temporary Employee
- Researcher
- Self-employed/Partner
- Other (specify)

What is your job title?

_____

If you graduated from college what was your major.

_____

If you had a minor please list what your minor was.

_____

What is your highest level of physics course you have taken?

_____

APPENDIX B

ACHIEVEMENT GOALS QUESTIONNAIRE

Please circle the number that accurately represents your current feelings towards the presentation you are about to watch and the subsequent questionnaires.

1= strongly disagree 2= disagree 3= somewhat disagree 4= neither disagree or agree
5= somewhat agree 6= agree 7= strongly agree

Circle One:

1 2 3 4 5 6 7   1. I want to learn as much as possible from this presentation.

1 2 3 4 5 6 7   2. It is important for me to understand the content of this presentation as thoroughly as possible.

1 2 3 4 5 6 7   3. I hope to have gained a broader and deeper knowledge of the content presented when I am done with this presentation.

1 2 3 4 5 6 7   4. I desire to completely master the material presented in this presentation.

1 2 3 4 5 6 7   5. I prefer course material that arouses my curiosity, even if it is difficult to learn.

1 2 3 4 5 6 7   6. I prefer course material that really challenges me so I can learn new things.

1 2 3 4 5 6 7   7. I am thinking to myself, "What if I do badly in this study?"

1 2 3 4 5 6 7   8. I worry about the possibility of getting a "bad grade" in this study.

1 2 3 4 5 6 7   9. My fear of performing poorly in this study is what is motivating me.

1 2 3 4 5 6 7   10. I just wanted to avoid doing poorly in this activity.

1 2 3 4 5 6 7   11. In a class setting I am afraid that if I ask my instructor a "dumb" question, they might not think I'm very smart.

1 2 3 4 5 6 7   12. I wish this activity was not graded.

APPENDIX C

ACHEIVEMENT GOALS QUESTIONNAIRE CODING

*LGO	1. I want to learn as much as possible from this presentation.
LGO	2. It is important for me to understand the content of this presentation as thoroughly as possible.
LGO	3. I hope to have gained a broader and deeper knowledge of physics when I am done with this presentation.
LGO	4. I desire to completely master the material presented in this presentation.
LGO	5. I prefer course material that arouses my curiosity, even if it is difficult to learn.
LGO	6. I prefer course material that really challenges me so I can learn new things.
**PAVOGO	7. I am thinking to myself, "What if I do badly in this study?"
PAVGO	8. I worry about the possibility of getting a "bad grade" in this study.
PAVGO	9. My fear of performing poorly in this study is what is motivating me.
PAVGO	10. I just wanted to avoid doing poorly in this activity.
PAVGO	11. In a class setting I am afraid that if I ask my instructor a "dumb" question, they might not think I'm very smart.
PAVGO	12. I wish this activity was not graded.

*LGO – Learning Goal Orientation
**PAVGO – Performance Avoidance Goal Orientation

APPENDIX D

PHYSICS PRE/POST TEST ALPHA

1. When the right-hand rule was applied to find direction of angular velocity for an object with a positive acceleration that is rotating in an x-y plane, the thumb ended up pointing in the positive z direction. What would be the direction of rotation and the z component of the angular acceleration of this object?
    a. The object would be rotating clockwise and the z component of the angular acceleration would be positive.
    b. The object would be rotating clockwise and the z component of the angular acceleration would be negative.
    c. The object would be rotating counterclockwise and the z component of the angular acceleration would be positive.
    d. The object would be rotating counterclockwise and the z component of the angular acceleration would be negative.

2. A top with a positive z component of angular velocity (ω) would be spinning in which direction?
    a. Clockwise
    b. Counterclockwise
    c. Undeterminable without knowing θ
    d. Undeterminable without knowing α

3. Assume that you are observing a wheel rotating in an x-y plane with a positive z component for angular acceleration and a negative z component for angular velocity, what would the rotation of the wheel look like?
    a. The wheel would be rotating clockwise and speeding up.
    b. The wheel would be rotating clockwise and slowing down.
    c. The wheel would be rotating counterclockwise and speeding up.
    d. The wheel would be rotating counterclockwise and slowing down.

4. Assume that you are observing a wheel that is rotating clockwise, what can you determine about the angular *acceleration*?
    a. It is positive.
    b. It is negative.
    c. Nothing unless you know angular velocity (ω)
    d. Nothing unless you know how the rotation speed is changing.

5. Assume that you made three observations of a wheel for 10 s each. On your third observation the angular displacement of the wheel increased relative to the first two observations. What implications would that have for the magnitude of the average angular velocity on the last interval?
    a. The magnitude of the average angular velocity was increasing.
    b. The magnitude of the average angular velocity was decreasing.
    c. The magnitude of the average angular velocity was remaining constant.
    d. The magnitude of the average angular velocity was changing depending on the current direction of the rotation.

6. Which of the following choices could cause the magnitude of the angular velocity of the wheel to decrease?
   a. The direction of the angular velocity is in the same as the angular acceleration.
   b. **The direction of the angular velocity is in the opposite direction of the angular acceleration.**
   c. The direction of the angular velocity is 0 while the angular acceleration decreases.
   d. The direction of the angular velocity is decreasing while the angular acceleration is 0.

7. Which rotational kinematics equation listed below would be required to solve the following problem? (Assume that $\omega 0$ is the initial angular velocity and $\omega 1$ is the final angular velocity.)
   What is the magnitude of the angular displacement of a wheel after 28s, if the wheel is rotating counterclockwise at a constant angular velocity of 15.3 rad/s?
   a. **$\omega 0\_z = \theta\_z/t$**
   b. $\omega 0\_z = \omega 1\_z + \alpha\_z*t$
   c. $\omega 0\_z^2 = \omega 1\_z^2 + 2* \alpha\_z*\theta\_z$
   d. $\omega 0\_z = v\_z/r$

8. Which rotational kinematics equation listed below would be required to solve the following problem? (Assume that $\omega 0$ is the initial angular velocity and $\omega 1$ is the final angular velocity.)
   How long would it take for a fan to stop if the initial rotation of 30 rad/s was in a clockwise direction within an x-y plane and had a constant negative acceleration of 2 rad/s^2?
   a. $\omega 0\_z^2 = \omega 1\_z^2 + 2* \alpha\_z*\theta\_z$
   b. **$\omega 1\_z = \omega 0\_z + \alpha\_z\ t$**
   c. $\omega 0\_z = \theta\_z/t$
   d. $\omega 0\_z = v\_z/r$

9. Assume that $\omega 0$ is the initial magnitude of angular velocity and $\omega 1$ is the final magnitude of angular velocity. Since there is a direct relationship between the concepts of rotation and translation the following translation equation, v1_x= v_x+a_x*t would be equivalent to which rotational kinematics equation?
   a. $\omega 0\_z^2 = \omega 1\_z^2 + 2* \alpha\_z*\theta\_z$
   b. **$\omega 1\_z = \omega 0\_z + \alpha\_z\ t$**
   c. $\omega 0\_z = \theta\_z/t$
   d. $\omega 0\_z = v\_z/r$

10. Assume that you have a top initially spinning in a clockwise direction at a 5 rad/s for 20 s and is accelerating at 10 rad/s^2. What is the z component of the angular velocity given in this problem?
    a. 5 rad/s
    b.   -5 rad/s
    c. 10 rad/s^2
    d. -10 rad/s^2

11. In a given situation where a car wheel slows to a stop at a rate of 15 rad/s^2 from initially rotating at 50 rad/s in an x-y plane. What is the z component of the vector for the magnitude of the angular acceleration?
    a. -50 rad/s
    b. 50 rad/s
    c. 15 rad/s^2
    d. -15 rad/s^2

12. If you know that a top is spinning in a clockwise direction in an x-y plane, then which of the following must be true?
    a. The magnitude of the angular velocity (ω) is positive.
    b. The magnitude of the angular velocity (ω) is negative.
    c. The magnitude of the angular acceleration (α) is positive.
    d. The magnitude of the angular acceleration (α) is negative.

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APPENDIX E

PHYSICS PRE/POST TEST BETA

1. When the right-hand rule was applied to find the direction of the angular velocity for an object with a positive acceleration that is rotating in an x-y plane, the thumb ended up pointing in the negative z direction. What would be the direction of rotation and the z component of the angular acceleration of this object?
    a. The object would be rotating clockwise and the z component of angular acceleration would be positive.
    b. **The object would be rotating clockwise and the z component of angular acceleration would be negative.**
    c. The object would be rotating counterclockwise and the z component of angular acceleration would be positive.
    d. The object would be rotating counterclockwise and the z component of angular acceleration would be negative.

2. A top with a z component angular velocity (ω) that was negative would be spinning in which direction?
    a. **Clockwise**
    b. Counterclockwise
    c. Undeterminable without knowing θ
    d. Undeterminable without knowing α

3. Assume that you are observing a wheel rotating in an x-y plane with a positive z component of angular acceleration and a negative z component of angular velocity, what would the rotation of the wheel look like?
    a. The wheel would be rotating clockwise and speeding up.
    b. **The wheel would be rotating clockwise and slowing down.**
    c. The wheel would be rotating counterclockwise and speeding up.
    d. The wheel would be rotating counterclockwise and slowing down.

4. Assume that you are observing a wheel that is rotating clockwise, what can you determine about the angular *acceleration*?
    a. It is positive.
    b. It is negative.
    c. Nothing unless you know angular velocity (ω)
    d. **Nothing unless you know how the rotation speed is changing.**

5. You made four observations of a wheel that is rotating in an x-y plane that lasted for 5 seconds each. On your last observation the angular displacement the wheel turned increased relative to the previous observations. What implications would that have on the magnitude of the average angular velocity on the last interval?
    a. **The magnitude of the average angular velocity was increasing.**
    b. The magnitude of the average angular velocity was decreasing.
    c. The magnitude of the average angular velocity was constant.
    d. The magnitude of the average angular velocity was changing depending on the current direction of the rotation.

6. An increase to the magnitude of the angular velocity of the wheel could be caused by which of the following?
    a. **The direction of the angular velocity is in the same as the angular acceleration.**
    b. The direction of the angular velocity is in the opposite direction of the angular acceleration.
    c. The direction of the angular velocity is zero while the angular acceleration decreases.
    d. The direction of the angular velocity remains constant as the angular acceleration is zero.

7. Which rotational kinematics equation listed below would be required to solve the following problem? (Assume that $\omega 0$ is the initial angular velocity and $\omega 1$ is the final angular velocity.)
    If the wheel is rotating counterclockwise at a constant angular velocity of 45.3 rad/s, what is the magnitude of the angular displacement of a wheel after 31s?
    a. **$\omega 0\_z = \theta\_z/t$**
    b. $\omega 0\_z = \omega 1\_z + \alpha\_z * t$
    c. $\omega 0\_z^\wedge 2 = \omega 1\_z^\wedge 2 + 2* \alpha\_z * \theta\_z$
    d. $\omega 0\_z = v\_z/r$

8. Which rotational kinematics equation listed below would be required to solve the following problem? (Assume that $\omega 0$ is the initial angular velocity and $\omega 1$ is the final angular velocity.)
    How long would it take for a wheel to stop if the initial rotation of 2π rad/s was in a clockwise direction within an x-y plane and had with a constant negative acceleration of 2 rad/s^2?
    a. $\omega 0\_z^\wedge 2 = \omega 1\_z^\wedge 2 + 2* \alpha\_z * \theta\_z$
    b. **$\omega 1\_z = \omega 0\_z + \alpha\_z \ t$**
    c. $\omega 0\_z = \theta\_z/t$
    d. $\omega 0\_z = v\_z/r$

9. Assume that $\omega 0$ is the initial angular velocity and $\omega 1$ is the final angular velocity. Since there is a direct relationship between the concepts of rotation and translation the following translation equation, v1_x= v_x+a_x*t would be equivalent to which rotational kinematics equation?
    a. $\omega 0\_z^\wedge 2 = \omega 1\_z^\wedge 2 + 2* \alpha\_z * \theta\_z$
    b. **$\omega 1\_z = \omega 0\_z + \alpha\_z \ t$**
    c. $\omega 0\_z = \theta\_z/t$
    d. $\omega 0\_z = v\_z/r$

10. Assume that you have a top initially spinning in a clockwise direction at a 10 rad/s for 20 s and is accelerating at 15 rad/s^2. What is the z component of the angular velocity given in this problem?
    a.   10 rad/s
    b.   -10 rad/s
    c.   15 rad/s^2
    d. -15 rad/s^2

11. In a given situation where a car wheel rotating in an x-y plane slows to a stop at a rate of 7 rad/s^2 from initially rotating at 25 rad/s. What is the z component of the vector for the magnitude of the angular acceleration?
    a. -25 rad/s
    b. 25 rad/s
    c. 7 rad/s^2
    d. -7 rad/s^2

12. What must be true, if a top is spinning in a clockwise direction in an x-y plane?
    a. The magnitude of the angular velocity (ω) is positive.
    b. The magnitude of the angular velocity (ω) is negative.
    c. The magnitude of the angular acceleration (α) is positive.
    d. The magnitude of the angular acceleration (α) is negative.

APPENDIX F

EXPERIMENTAL SCRIPT

S = Student T = Tutor

S: Hi, my name is Scotty and I am here for tutoring.

T: Hi Scotty what can I help you with today?

S: I need to learn about rotational kinematics. Specifically, I need to learn how to solve problems such as determining the stopping time of a body in motion such as a wheel.

T: Wow rotational kinematics. Seems like a tough subject. What made you want to take a course on that?

S: Well I had already learned basic laws of physics I am now interested in learning about rotational kinematics. It might be difficult, but that is just part of learning. I can still learn it..

T: Ok well let's start off with you telling me what you already know and then well try a sample problem.

S: Well rotational kinematics is a branch of physics that deals with objects in a rotating motion. It involves elements such as angular displacement, angular velocity and angular acceleration. I need to learn how to apply these aspects to solve for problems so that I can apply them later to similar physics problems.

T: Tell me what you know about those elements.

S: I need to learn how to apply the information I already know to solve rotational kinematic problems. For instance, I know angular displacement is represented by the theta symbol and is the angle through which a point has been rotated about a specified axis. Angular velocity is the rate of change of an angular displacement and is a vector quantity which measures the speed of an object and the axis about which the object is rotating. It is represented by the omega symbol. Angular acceleration is the rate of change in angular velocity and is represented by the alpha symbol.

T: Good you know some of the basics so let's try this sample problem and you can talk through it. "A wheel is rotating counterclockwise at a constant angular velocity of pi radians per second. Through what angle does the wheel rotate in 60.0 seconds?" Tell me how you would work through this using what you already know.

S: So I know I need to define my axis because it establishes the x,y plane. This is important to know because it tells us the directionality of the rotation either clock wise or counter clock wise. I learned the standard right hand rule that if you rotate the fingers of your right hand from the x to the y axis the thumb of your right hand will point at the positive.

T: emhmm. What else?

S: I'm a bit nervous that I may give the wrong information because this material is a lot more complex than I expected. My goal is to increase my knowledge of rotational kinematics and I am determined to learn this material.

T: That's a good attitude to have. If you hit a roadblock I am here to help you work through it. So go ahead and talk through the rest. You want to establish the x,y plane and you have told me why so what's next?

S: The wheel is rotating counterclockwise which means it will be out of the x,y plane in the positive x direction. This is important because as we talked about before it establishes directionality and this allows me to move on to angular velocity of the object. I think I can go ahead and start building my formula.

T: Yep. Go ahead and let's work on the formula.

S: I now need to determine the angular velocity. Ok so angular velocity, we define the start time of the rotation. So we will call this T zero.

T: How about we think about this again. What do else do you know about average velocity and time?

S: Opps, I think I am confused. Let me think through this some more.. The problem deals with an average velocity, so it can't occur at one point in time. Which would make it an interval of time. Oh which means I should probably re-label this to be T zero to T one.

T: Right! Way to identify the error.

S: OK, on to the next step in solving this. Next would be my z component and to solve this I need to incorporate the information I already know. I know that because it is going counter clock wise it is going to be positive. Also that pi will be measured in radians per second and if I go back to my problem I know the duration of time is 60 seconds so T one will have a value of 60 seconds.

T: What would you do next?

S: For my next step, it is important to define theta. I know I am solving for angular displacement which means I need to define theta and this is important because it is going to tell me how fast the wheel is turning.

T: How does that fit into the equation?

S: It is important to remember what modifies theta. Within the equation theta is multiplied by time.

T: Ok so put together your equation to solve.

S: I have the angular displacement in the z direction and the angular velocity in the z direction multiplied by time. I need to incorporate all of this information and use it to solve for the angle the wheel will rotate.

T: And again is the z direction positive or negative?

S: It is positive because it is going counter clockwise which again is important when to remember the relationship between the direction of z and rotation.

T: Right. So do you think you have your answer?

S: . I knew that I would be able to do this if I did not give up! I got 188 radians.

T: Correct!

S: Ah. Ok that wasn't as difficult as I thought it would be. Now that I have worked through that problem can I try another? I want to be sure I can apply what I know and what I just worked through to other problems. It's really important to me that I understand this material so not only can I just increase my knowledge of the subject but it also make's me curious to learn about other aspects of physics.

T: Of course we can try another problem. How about this one, it has two parts. The first part is, 'an electric grinding wheel is initially rotating counter-clockwise at 10.0 radians per second when it is turned off. Assume a constant negative angular acceleration of .500 radians per second squared. How long does it take the wheel to stop? And the second part of the question is: through how many radians does the wheel turn before comes to a complete stop?'

S: Ok. Wow this is a bit more complex but if I could do the other I can do this. I'll start by breaking the problem down.

T: Sounds like a good plan. Go ahead and talk through the problem.

S: So the body in motion is the wheel. Then we'd place the coordinate system and it's going to be zero since it's going to be going along the positive x-axis.

T: And again in these rotational problems we need a coordinate system for what reason?

S: To find if the Z direction is going to be either positive or negative.

T: It's a useful tip to remember. What's next?

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S: I'll go ahead and define my variables. It is important for me to define the variables so I can use my knowledge of them to help understand the larger problem.

T: Alright. Go ahead and do that.

S: I need to define my time and what direction the wheel is rotating. The initial rotating velocity is 10 radians per second. So time will be T0, it's going to be out of the plane. The Z component is going to equal 10 radians per second.

T: Again plus or minus?

S: I need to determine the direction of z. it's going to be plus since it's going counter-clockwise which means the z direction is going to be positive.

T: Very good. What's next?

S: Next I need the angular acceleration. We then have a constant negative angular acceleration of .5 radians per second squared. …

T: Now we got to think if it is slowing down what is going to be its direction relative to omega zero?

S: I need to know the relationship between angular acceleration and Omega 0. Hmm I know it is going to be into the plane and it's going to be negative.

T: Very good.

S: So into the plane. Ok um this is getting a bit complicated I am just trying to remind myself this is all part of the learning process. Angular acceleration of the wheel it's going to be an average during the time T0 to T1 and we'll just name it alpha one. Okay so with the Greek letter alpha and then we have alpha one in the Z direction equals… now since it's on our vector on the graph we have it saying it's negative do I have to put …

T: yes you still must declare…

S: …it to be negative?

T: Good question.

S: Okay, I know I am almost done I just need to remember to use what I already know to solve for this. Then other problems won't be as difficult. Ok so I have radians per second squared.

T: Correct

S: Okay. Then I have to find how long it takes for the wheel to stop which means I need a counter variable. I know that T is the duration of time and it's going to be from T0 to T1 and we'll name it T01 and it's going to be an unknown variable. I know one z equals zero radians per second.

T: So what's the final velocity equal to?

S: I need to determine t01. Alpha one and z multiplied by time which is going to be t01.

T: and do have everything you need to solve?

S: Um I believe I do. I needed to define the variables final velocity, initial velocity and acceleration in order to solve for t01. I used that information to solve for the first part of the question, how long does it take the wheel to stop? I got 20 seconds.

T: Good job!

S: Thanks I am feeling a bit more confident. That section was tough but it was important for me to solve that in order to know information for the second portion. Now we have to find how many radians does the wheel turn before it comes to a complete stop.

T: So what kind of variable is that?

S: That is going to be an angular displacement. Angular displacement is an important component for me to apply to solve this Rotational Kinematics problem. I need to use the displacement vector and do direction on the z it will be… since it's going to turn it counterclockwise it will be out of the plane

T: Very good.

S: So it's an angular displacement of the wheel at time t0 to t1 out of the plane and well make it one. This is going to be one equals the…omega one in the z direction.

T: And what's that first term? That first term is an angular velocity.

S: First initial angular velocity. Oh it's going to be omega zero…Wow this can be confusing but now that I know it'll be omega zero not omega one it probably won't be as difficult the next time.

T: Right.

S: Ok let me get back on track and use what I know to set up the rest of this problem… I have omega zero in the z direction and that's going to be times time. So it'd be T0 one and then you will add one half … .5… the angular acceleration which is going to in the z direction times time which is T01…Quantity squared.

T: Now I want to remind you if you look at your equation you have to have an explicit multiplication sign between all the terms.

S: So between the point five and the Alpha.

T: Right.

S: Alright

T: So the second term is the change in the displacement due to the fact the angular velocity was changing.

S: Right again let me take note of that to remind myself in the future when working on similar problems. Wow this subject is a lot more complicated than I ever expected but this challenge is fun. Ok so now to solve we want it in the z direction, the angular displacement so using the variables I defined before and using what I know I have 100 radians as the answer.

APPENDIX G

CONTROL SCRIPT

S = Student T = Tutor

S: Hi, my name is Scotty and I am here for tutoring.

T: Hi Scotty what can I help you with today?

S: I need some help on rotational kinematics to solve problems like determining the stopping time of a body in motion such as a wheel.

T: Wow rotational kinematics. Seems like a tough subject. What made you want to take a course on that?

S: Well I had already learned the basic laws of physics and I am now interested in learning about rotational kinematics.

T: Ok well let's start off with you telling me what you already know and then well try a sample problem.

S: Well rotational kinematics is a branch of physics that deals with objects in a rotating motion. It involves elements such as angular displacement, angular velocity and angular acceleration.

T: Tell me what you know about those elements.

S: For instance, I know angular displacement is represented by the theta symbol and is the angle through which a point has been rotated about a specified axis. Angular velocity is the rate of change of an angular displacement and is a vector quantity which measures the speed of an object and the axis about which the object is rotating. It is represented by the omega symbol. Angular acceleration is the rate of change in angular velocity and is represented by the alpha symbol.

T: Good you know some of the basics so let's try this sample problem and you can talk through it. "A wheel is rotating counterclockwise at a constant angular velocity of pi radians per second. Through what angle does the wheel rotate in 60.0 seconds?" Tell me how you would work through this using what you already know.

S: I define my axis to establish the x,y plane. This tells us the directionality of the rotation either clock wise or counter clock wise.

T: You want to establish the x,y plane and you have told me why so what's next?

S: The wheel is rotating counterclockwise which means it will be out of the x,y plane in the positive z direction. I learned the standard right hand rule that if you rotate the fingers of your right hand from the x to the y axis the thumb of your right hand will point at the positive.

T: Yep. Go ahead and let's work on the formula.

S: Ok so angular velocity, we define the start time of the rotation. So we will call this T zero.

T: How about we think about this again. What do else do you know about average velocity and time?

S: The problem deals with an average velocity, so it can't occur at one point in time. Which would make it an interval of time. Oh which means I should probably re-label this to be T zero to T one.

T: Right! Way to identify the error.

S: Next is the z component which is 60 seconds so T one will have a value of 60 seconds.

T: What would you do next?

S: I would solve for theta which represents angular displacement or how fast the wheel is turning.

T: How does that fit into the equation?

S: Within the equation theta is multiplied by time.

T: Ok so put together your equation to solve.

S: I have the angular displacement in the z direction and the angular velocity in the z direction multiplied by time.

T: And again is the z direction positive or negative?

S: It is positive because it is going counter clockwise.

T: Right. So do you think you have your answer?

S: I think I do. I got 188 radians.

T: Correct!

S: Could we do another problem?

T: Of course we can try another problem. How about this one, it has two parts. The first part is, 'an electric grinding wheel is initially rotating counter-clockwise at 10.0 radians

per second when it is turned off. Assume a constant negative angular acceleration of .500 radians per second squared. How long does it take the wheel to stop? And the second part of the question is: through how many radians does the wheel turn before comes to a complete stop?'

S: Ok. I'll start by breaking the problem down.

T: Sounds like a good plan. Go ahead and talk through the problem.

S: So the body in motion is the wheel. Then we'd place the coordinate system and it's going to be zero since it's going to be going along the positive x-axis.

T: And again in these rotational problems we need a coordinate system for what reason?

S: To find if the Z direction is going to be either positive or negative.

T: It's a useful tip to remember. What's next?

S: I'll go ahead and define my variables.

T: Alright. Go ahead and do that.

S: The initial rotating velocity is 10 radians per second. So time will be T0, it's going to be out of the plane. The Z component is going to equal 10 radians per second.

T: Again plus or minus?

S: It's going to be plus on the since it's going to counter-clockwise which means the z direction is going to be positive.

T: Very good. What's next?

S: We then have a constant negative angular acceleration of .5 radians per second squared.

T: Now we got to think if it is slowing down what is going to be its direction relative to omega zero?

S: It's going to be negative.

T: Very good.

S: So into the plane. Angular acceleration of the wheel it's going to be an average during the time T0 to T1 and we'll just name it alpha one. Okay so with the Greek letter alpha

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and then we have alpha one in the Z direction equals… now since it's on our vector on the graph we have it saying it's negative do I have to put …

T: yes you still must declare…

S: …it to be negative?

T: Good question.

S: Ok so I have radians per second squared.

T: Correct

S: Then I have to find how long it takes for the wheel to stop which means I need a counter variable. I know that T is the duration of time and it's going to be from T0 to T1 and we'll name it T01 and it's going to be an unknown variable. I know one z equals zero radians per second.

T: So what's the final velocity equal to?

S: Alpha one and z multiplied by time which is going to be t01.

T: and do have everything you need to solve?

S: Yes, I have final velocity, initial velocity and acceleration. It will take 20 seconds for the wheel to stop.

T: Good job!

S: Now we have to find how many radians does the wheel turn before it comes to a complete stop.

T: So what kind of variable is that?

S: That is going to be an angular displacement. I need to use the displacement vector and do direction on the z it will be… since it's going to turn it counterclockwise it will be out of the plane

T: Very good.

S: So it's an angular displacement of the wheel at time t0 to t1 out of the plane and well make it one. This is going to be one equals the…omega one in the z direction.

T: And what's that first term? That first term is an angular velocity.

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S: First initial angular velocity. Oh it's going to be omega zero…

T: Right.

S: I have omega zero in the z direction and that's going to be times time. So it'd be T0 one and then you will add one half … .5… the angular acceleration which is going to in the z direction times time which is T01…Quantity squared.

T: Now I want to remind you if you look at your equation you have to have an explicit multiplication sign between all the terms.

S:. So between the point five and the Alpha.

T: Right.

S: Alright

T: So the second term is the change in the displacement due to the fact the angular velocity was changing.

S: Ok so now to solve we want it in the z direction, the angular displacement so using the variables I defined before and using what I know I have 100 radians as the answer.

T: You did great.

APPENDIX H

CONSENT FORM

<u>CONSENT FORM</u>
An Investigation of the Role of Goal Setting during Vicarious Learning of Physics

<u>INTRODUCTION</u>
The purposes of this form are to provide you (as a prospective research study participant) information that may affect your decision as to whether or not to participate in this research and to record the consent of those who agree to be involved in the study.

<u>RESEARCHERS</u>
Arizona State University College of Innovation and Technology's Scotty D. Craig, Ph.D and Jessica B. Twyford have invited your participation in a research study.

<u>STUDY PURPOSE</u>
Several studies have been conducted looking into the subject of learning from a virtual agent however none have explored how specific dialogue characteristics influences learning and goal orientation.

<u>DESCRIPTION OF RESEARCH STUDY</u>
If you decide to participate, then you will join a study involving research of learning via virtual humans in a multimedia setting. Participants will be randomized into one of two groups. Certain aspects of the dialogue will be the only thing that changes between the settings the educational information presented will be the same within each condition. You will be randomly assigned to one of the two conditions in that you have an equal chance of being in any of the conditions.
If you say YES, then your participation in this online study will last for approximately 45 minutes. You will be asked to take three brief questionnaires, watch a presentation on the formation of rotational kinematics and then fill out another series of questionnaires. You will be given a code at the end of the study to prove you have participated. Please save this code to enter into Amazon Mechanical Turk to receive credit.
Approximately 130 people will be participating in this study.

<u>RISKS</u>
There are no known risks from taking part in this study, but in any research, there is some possibility that you may be subject to risks that have not yet been identified.

<u>BENEFITS</u>
A better understanding of the formation of rotational kinematics and possible changes in learning goal orientation.

<u>CONFIDENTIALITY</u>
All information obtained in this study is strictly confidential. The results of this research study may be used in reports, presentations, and publications, but the researchers will not identify you. In order to maintain confidentiality of your records, Scotty D. Craig, Ph.D and Jessica Twyford will ensure no identifying information will be collected that will link the data to the individual it was collected from. All data will be kept electronically and

will be deleted after a 5 year period from the date of publication as is customary with the field.

WITHDRAWAL PRIVILEGE
Participation in this study is completely voluntary. It is ok for you to say no. Even if you say yes now, you are free to say no later, and withdraw from the study at any time.

COSTS AND PAYMENTS
The researchers want your decision about participating in the study to be absolutely voluntary.
Yet they recognize that your participation may pose some timely inconvenience. In order to) compensate you will receive $1.00 in your MTurk account.

VOLUNTARY CONSENT
Any questions you have concerning the research study or your participation in the study, before or after your consent, will be answered by Scotty D. Craig, Ph.D. or Jessica Twyford at Santa Catalina Hall, Ste. 150, 7001 E. Williams Field Road, Mesa, Arizona 85212. Phone: 480-727-4723

If you have questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk; you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at 480-965 6788.

Clicking on the button below indicates your consent to participant in this research study. If you do not wish to continue with the study please exit now.

APPENDIX I

AGENT PERSONA INSTRUMENT

1 = strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = strong agree

1. The agent led me to think more deeply about the presentation.
2. The agent made the instruction interesting.
3. The agent encouraged me to reflect what I was learning.
4. The agent kept my attention.
5. The agent presented the material effectively.
6. The agent helped me to concentrate on the presentation.
7. The agent focused me on the relevant information.
8. The agent improved my knowledge of the content.
9. The agent was interesting.
10. The agent was enjoyable.
11. The agent was knowledgeable.
12. The agent was intelligent.
13. The agent was useful.
14. The agent was helpful.
15. The agent was instructor-like.
16. The agent has a personality
17. The agent's emotion was natural.
18. The agent was human-like.
19. The agent's movement was natural.
20. The agent showed emotion.
21. The agent was expressive.
22. The agent was enthusiastic.
23. The agent was entertaining.
24. The agent was motivating.
25. The agent was friendly.