Can the gamification element *storytelling* increase motivation and learning outcomes of students in higher education in an online inquiry-based-learning environment?

Bachelor Thesis

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Abstract

Motivation is a source of fuel for a wide range of activities. Academic achievement is one of the things that is influenced by motivation. Especially intrinsic motivation is an indicator for academic success. To increase intrinsic motivation Inquiry-Based-Learning can be introduced. IBL incorporates different phases of learning in the research process and enhances the active engagement in the learning process and with that increases autonomy. Autonomy increasing instruction forms in turn increase intrinsic motivation according to the Self-Determination Theory (SDT). And an increased intrinsic motivation is a strong indicator for better learning outcomes. In addition to the IBL, gamified online learning environments seem to have an impact on intrinsic motivation as well, as studies reveal a relationship between gamified online learning environments, motivation and learning outcomes. Therefore this study investigates the influence of the gamification element storytelling in an online IBL environment on motivation and learning outcomes in higher education students. Two comparable IBL online environments have been created and one of them includes the gamification element. The participants are higher education students and the mean age of the study is 21. Within-and between-subject analyses have been executed to compare the motivation of the participants before and after the participation. Additionally the differences in motivation and their learning outcomes between the groups have been analyzed. The results revealed no significant differences between the groups in motivation and learning outcomes. Also the within-subject analysis revealed no significant differences in motivation before and after the participation. Nevertheless more research is needed in this field as different gamification elements might have different relationships. Furthermore the research in this field is highly recommended as online learning is more and more popular.

The influence of gamification aspects on motivation and learning in an online inquiry learning environment

Learning is a companion in everyday life. People start to learn things already in the womb and they do not stop learning for the rest of their lives. Especially during their academic education students are confronted with the demands to learn. Unlike learning in daily life, learning in an academic environment is not such a hands-on experience in "traditional" instruction forms. More concretely, there are "traditional" instruction methods which are set up more passively in regards to the students, for instance direct instruction as being the most widely used form. It is a skills-oriented teacher-directed instruction form with the use of face-to-face instruction by the teachers (Carnine, et. al., 2010).

In contrast to that there are also instructional methods which are set up more actively in which the students can actively engage in to acquire knowledge, one of which is inquiry-based learning in online learning environments. It is an instruction form in which the learners go through phases of learning similar to professional scientists in order to acquire new knowledge in an unknown topic (Pedaste, et. al., 2015).

Next to that, gamification is an additional element which is now widely used in instruction forms. It can be included in the inquiry-learning online environments with the intention to increase motivation and therefore enhance learning outcomes of students (Caponetto, Earp, & Ott, 2014). The use of different instruction methods and tools might influence learning outcomes and motivation of students. Hence this paper will focus on the influence of gamification elements in online inquiry-learning environments on motivation and learning outcomes for university and other higher education students.

Motivation

Motivation is fuel for people. Without any motivation people would not get out of their bed at 6 am to go to work, to the gym or to go school. Motivation is individual and everyone has their own motivating goals to engage in a certain behaviour (Deci, & Ryan, 2008).

It is known that students' motivation to go to school decreases after the first two years in elementary school (Tohidi, & Jabbari, 2012). This phenomenon jeopardizes the learning outcomes of students. The main reason for this is that the learning outcomes of students seem to highly depend on motivation. Although motivation is a great indicator of academic performance, it is influenced by other factors as well. For instance the teachers have a great influence on their students' motivation with their communication, their own motivation they project onto their students and their emotional state as well (Taurina, 2015). Motivation for academic engagement can be increased as well as decreased by teachers with the use of different instruction forms and with the use of different tools such as online-learning environments (Özhan, & Kocadere, 2019; Chen, & Jang, 2010).

Conceptualization of Motivation

Motivation can be divided into two subcategories: intrinsic motivation and extrinsic motivation. Extrinsic motivation is influenced from environmental factors. That is to say rewards like money or grades or punishment motivates a person to commit to a behaviour. In the academic environment examples of extrinsic motivation could be grades, competition or the punishment following “bad” learning outcomes. Extrinsic motivation is oftentimes induced by teachers when students are not intrinsically motivated to follow the academic demands (Tohidi, & Jabbari, 2012).

Nevertheless there is a disadvantage with the use of extrinsic motivation factors. Psychologists have reported that the overuse of extrinsic motivation can lead to a decrease in

intrinsic motivation in people. Students who were previously intrinsically motivated to complete a task are less intrinsically motivated afterwards when they are regularly rewarded (extrinsic motivation) for completing that task. If there is no reward expected anymore, they tend to stop wanting to continue with this task (Tohidi, & Jabbari, 2012).

Intrinsic motivation is the pure internal enjoyment and interest in a certain activity or task. It is associated with high academic achievement, hence people who are intrinsically motivated in the academic environment seem to have better learning outcomes, compared to students who are not intrinsically motivated (Tohidi, & Jabbari, 2012). These results were also validated in a study by Kusurkar and colleagues (2012). The researchers analyzed whether there is a difference in the performance of 383 students of the VU University Medical Center Amsterdam depending on the quality of their motivation. As expected the results indicated that autonomous motivation (intrinsic motivation) results in better performance due to better study strategies and higher study effort (Kusurkar, et. al, 2012). To measure intrinsic motivation the Questionnaire on Current Motivation (QCM) is suitable. The scale *Interest* is compatible with intrinsic motivation and it is shown to be useful in the assessment of intrinsic motivation (Söbke et. al., 2020). Various studies incorporate the QCM for the assessment of intrinsic motivation (Bedek et. al., 2015; Söbke et. al., 2020) .

QCM

The Questionnaire on Current Motivation (QCM) assesses motivation based on four scales *Anxiety, Challenge, Probability of Success* and *Interest* (Rheinberg et. al., 2001). The QCM measures the current motivation of people. According to Rheinberg, Vollmeyer and Burns (2001) there is a difference in personal and situational factors which result in a desired behaviour such as higher engagement in the academic environment. Personal factors are described as

characteristics or *motives* a person possesses, which have preferences towards specific stimuli to engage in a certain behaviour. Situational factors are stimuli in a given situation which might fit to the personal factors, stimulate the *motive* and in turn influence the behaviour of a person. Which means that a behaviour is a result from the interaction between personal- and situational factors and if the situational factors are fitting the personal factors, current motivation is caused and the behaviour of a person is influenced. Thus current motivation is the crucial factor to influence behaviour (Rheinberg et. al., 2001).

Based on this assumption Rheinberg and his colleagues (2001) establish the QCM measuring current motivation based on *Anxiety, Challenge, Probability of Success* and *Interest.* *Anxiety* relates to the feeling of pressure and the fear of failing a certain task, a low level of anxiety indicates a more positive connotation of the given task. *Challenge* assesses the degree to which the task is experienced as challenging. *Probability of Success* measures the certainty to succeed in a task, which means a high probability of success indicates that the learner is confident about their ability in a task. And lastly *Interest* measures the extent to which the task arouses interest in the learner (Rheinberg et. al., 2001).

The scales *Anxiety* and *Probability of Success* aim to assess the motivational aspects based on the current evaluation of success or failure in the current task. Whereas *Challenge* and *Interest* assess motivation by measuring the motivation system that is addressed in the learning environment, which are the motivation about the content of the task and the chance to assess one's own abilities in the given task (Rheinberg et. al., 2001).

In learning environments which are more teacher directed, the scales for *Interest* or *Challenge* cannot influence motivation and learning outcomes, as they are solely expected to work on the given task. However, for tasks where self-directed learning is expected, such as in

Inquiry based learning all four scales are of importance to have an increased motivation and with that good learning outcomes. The reason for that is for the self-directed learning a higher engagement is expected as the learner has to coordinate and organize the learning strategies on their own (Rheinberg et. al., 2001). Thus the QCM measures the current motivation of people in a learning environment which is designed for self-directed learning. This measurement tool aligns with the self-determination theory (SDT) as autonomy enhancing instruction forms are crucial for increased motivation and increased learning outcomes (Hsu, Wang, & Levesque-Bristol, 2019).

SDT

Ryan and Deci (2000) define the SDT as "the investigation of people's inherent growth tendencies and innate psychological needs that are the basis for their self-motivation and personality integration, as well as for the conditions that foster those positive processes." (Ryan, & Deci, 2000, p. 68). According to SDT motivation is determined by three psychological needs which need to be fulfilled in order to be self-determined. Autonomy, competence and relatedness are the three psychological needs that need to be satisfied. Autonomy describes the feeling of having options in a given situation, for instance having the opportunity to work in their own way as a student in the classroom. Competency is the feeling of being capable of handling a given situation as if the student is able to see their own progress academically. Lastly, relatedness is being connected with others, in the context of education it can be the interaction with classmates or with the given topic (Hsu, Wang, & Levesque-Bristol, 2019).

As explained in the article by Hsu and colleagues (2019), in order to satisfy the three psychological needs in the academic context, autonomy enhancing instruction forms are beneficial, such as inquiry based learning and gamification (Kim, & Castelli, 2021). With the use

of autonomy enhancing instruction form the three psychological needs can be satisfied and this in turn might lead to self-regulated learning, increased intrinsic motivation and better learning outcomes (Hsu, Wang, & Levesque-Bristol, 2019).

What is Inquiry-Based Learning?

Inquiry-based learning (IBL) can be defined as "a process of discovering new causal relations, with the learner formulating hypotheses and testing them by conducting experiments and/or making observations" (Pedaste, et al., 2015). Within IBL learners are encouraged to imitate the process of scientific work by working through phases within a cycle. IBL is divided into five phases conceptualized as *Orientation, Conceptualization, Investigation, Conclusion* and *Discussion* (Pedaste, et al., 2015).

During the first phase of the cycle the students are asked to get familiar with the topic at hand and come to a problem statement. Following this, the students enter the *Conceptualization* phase, within which the students generate a research question and hypotheses. Next to that, during the *Investigation* phase the students take action and engage in observation and/or experimentation. Within this phase the students work on answering their previously defined research question and either rejecting or accepting their hypotheses. Subsequently they come into the *Conclusion* phase in which they have to derive a conclusion based on the results from their investigation and with that answer their research question and hypotheses. Lastly the students engage in the *Discussion* phase, where they have the opportunity to reflect on what they have learned, how the process of the whole investigation went and if a new cycle should be started due to the insights into the problem.

It is important to note that although it is described as a step-by-step process in which the next phase can only begin if the preceding one ends, that is not the case. It is a cyclic process,

which means the students have the opportunity to change the paths and go one step back if problems occurred or mistakes were made. As it is illustrated in the article by Pedaste (2015) and colleagues, there are numerous routes which can be used to work through the problem at hand (see Figure 1) (Pedaste, et al., 2015).

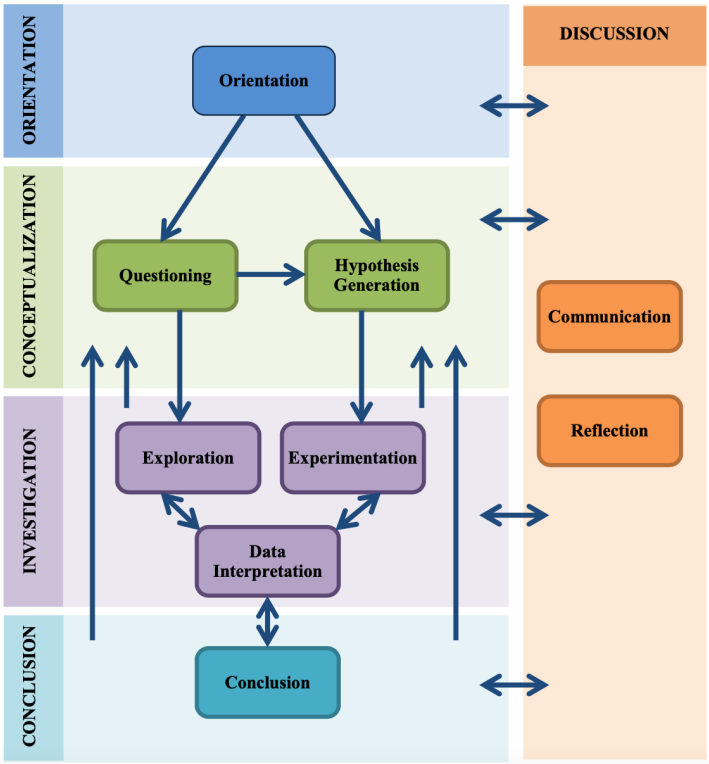

Figure 1. Illustration of the routes to work in the Inquiry cycle

Inquiry-Based Learning Effectiveness

IBL has shown to be highly effective in science education of primary education students compared to traditional instruction forms as shown in the meta-analysis by Aktamis and colleagues (2016). In their investigation the researchers analyzed 16 studies which compared the academic achievement of students in regard to IBL and traditional instruction forms, resulting in 15 studies being in favor of IBL and showing better learning outcomes and comprehension in science. Consequently indicating a large impact of the used instruction method on the learning outcomes (Aktamis, Higde, & Özden, 2016).

Besides the increased learning outcomes it can be also noted that students show an increase in motivation when engaging in IBL. According to Romero-Ariza and her colleagues (2019) the hands-on experiences during the IBL phases result in an increased motivation in the learning process. In their study they assessed the teachers' point of view on IBL and their results showed that teachers are aware and are having a positive attitude towards the motivating aspect of IBL. They reported that the active engagement in a task positively influences the motivation of their students (Ariza, et. al., 2019).

Consequently it has been proven that IBL results in better learning outcomes and increased motivation of students, however it is important to note that the kind of implementation by the teachers is highly important for an IBL to be effective. It has been shown that students might be overwhelmed by the IBL phases and the cycle, when they are not guided through the process by their teachers (Jong, 2006).

For instance Shih and his colleagues (2012) discovered that with the implementation of IBL in primary schools the students' learning outcomes increased and additionally the students' satisfaction levels were high, hence they showed more engagement in their task. Nevertheless, they stress the importance of thorough guidance during the whole process and during each step within IBL, for instance with mobile devices guiding the students through the whole process (Shih, Chuang, & Hwang, 2012). The same advice is also expressed in the paper by Bruder and Prescott (2013) in which they put attention to the importance of *guided IBL*, which can be summed up as the teacher guiding the students through each step during the IBL phases (Bruder , & Prescott, 2013).

In his article Jong (2006) illustrates that students have major issues with the adaptation of the process. It seems to be too complicated to come up with testable hypotheses, draw the correct

conclusion from their observation/experiment and link together different events. Subsequently, Jong suggested making use of another tool to guide students through the inquiry cycle, namely online environments (Jong, 2006).

Online Learning-Environments

Online learning environments are classified as such if the internet is used to provide instruction to the learners independent of time and distance (Demsey, & Van Eck, 2002 as cited in Cheng and Jang, 2010). It can be used as a tool in education to increase motivation and learning outcomes. They offer high flexibility and easy access both for students and teachers. Teachers have the opportunity to monitor and observe their students' learning progress. Students on the other hand become more self-directed (Mukhtar et. al., 2020).

There is evidence that online-learning environments seem to increase motivation and subsequently result in better learning outcomes. Cheng and Jang analyzed motivation in online learning based on the self-determination theory (SDT) and the results confirmed that online learning environments increase motivation (Chen, & Jang, 2010). Especially in the combination with gamification aspects (Özhan, & Kocadere, 2019). Nevertheless it is not well defined which gaming elements have an impact on motivation and learning outcomes of students. Therefore it is of interest to analyze each gamification element separately to understand which one is most prominent in influencing motivation and learning outcomes.

Gamification

Gamification is an instruction form in the academic context which includes gaming elements in order to increase the students motivation in learning. Different to serious games, which are designed with a clear purpose and a predefined aim, gamification is the adaptation of game elements in learning to increase motivation (Kiryakova, Angelova, & Yordanova, 2014).

Toda and his colleagues (2019) identified five dimensions of gamification and within each dimension there is a set of elements which can be incorporated in an online gamified inquiry learning environment. The dimensions are *performance/measurement*, *ecological*, *social*, *personal*, and *fictional* (see Figure 2) (Toda, et al., 2019).

To start off with *performance/measurement* it is the feedback that the learner receives from their environment and it includes the elements *point, progression, level, stats* and *acknowledgement*. *Ecological* is described as the context of the gamified environment. It includes the elements *chance, imposed choice, economy, rarity* and *time pressure*. *Social* is the dimension that describes the interaction of the learner with the gamified environment containing the elements *competition, cooperation, reputation* and *social pressure.* The dimension which is described as the relatedness of the learner is *personal* it incorporates the gamification elements *novelty, objectives, puzzle, renovation* and *sensation.* Lastly *fictional* is the dimension that connects the learner with the environment, including the elements *narrative* and *storytelling* (Toda, et al., 2019).

Each of the gamification dimensions with its elements trigger different aspects within a person, making the inquiry learning environment more or less interesting, increasing or decreasing the motivation to engage in students.

Generally it has been assessed that gamification increases students' motivation as well as learning outcomes. In their study Buckley and Doyle (2014) investigated the influence of gamification on learning outcomes with 156 students within a period of three weeks comparing the results of pre- and post-surveys. Their results indicate a significant relationship between learning outcomes and motivation, hence in their study the introduction of gamification increased learning outcomes (Buckley, & Doyle, 2014).

An example of the effect of a concrete gamification element is described in the meta-analysis by Kim and Castelli. In their meta-analysis Kim and Castelli (2021) determine that the introduction of badges when completing a certain task increases motivation and engagement in learners. The explanation for this result lies in SDT, according to Kim and Castelli the introduction of a gamification element like badges fulfills the three psychological needs to become intrinsically motivated. Accordingly, the learners are higher in intrinsic motivation and show better learning outcomes (Kim, & Castelli, 2021).

Storytelling is expected to decrease anxiety in students. A study by Rini and colleagues investigated whether storytellin in an online platform can decrease anxiety in students while speaking English. Their results confirmed their assumption and it has been revealed that using storytelling can help the students to decrease their anxiety in regards to speaking English (Rini et. al., 2020). However this study does not indicate whether storytelling can decrease anxiety in a learning environment without speaking but only the learning behaviour.

Additionally it has been proven that storytelling seems to affect perceived probability to success within learners. In his research Bury investigated the influence of storytelling in Japanese students from the Faculty of Tourism and Business Management. The analysis revealed not only an increase of the learning outcomes but also their perception of their own abilities increased after the introduction of storytelling in their learning materials (Bury, 2019).

Higher engagement and interest can also be results of the introduction of storytelling in the educational context. Baldwin and Ching investigated interactive storytelling in online learning environments and came to the conclusion that storytelling is a helpful tool to increase interest by decreasing their cognitive load (Baldwin, & Ching, 2016). Similar results have also been revealed in the literature review by Freeman and Burkette (2019). Storytelling not only

increases interest and with that engagement in the task, it also enhances critical thinking skills of the learners as well which in turn increases motivation (Freeman, & Burkette, 2019).

Similarly it has been discovered that narrative systems like storytelling can have an impact on learning in students. As mentioned before, storytelling can be a tool for cognitive organization of experiences, which increases critical thinking of causal relationships (Freeman, & Burkette, 2019). In the context of gamified online learning environments this might indicate that students have an increased understanding of cause and effect with the use of narrative systems. In their study Lindgren and McDaniel investigated this hypothesis in 129 university students. The results showed that the students' learning outcomes and their engagement and with that their motivation is higher when narrative systems such as storytelling are used in online learning environments, which confirms the hypothesis (Lindgren, & McDaniel, 2011).

Figure 2. Taxonomy of gamification

Current Study

As the results of the above mentioned studies show motivation is one of the strongest indicators for learning outcomes of students, especially intrinsic motivation (Tohidi, & Jabbari, 2012). It has also been established that an effective way of increasing intrinsic motivation in the academic context lies in fulfilling the three psychological needs according to the SDT. This can be reached with the use of autonomy enhancing instruction forms, which lead to self-regulated learning, higher intrinsic motivation and with that in increased learning outcomes (Hsu, Wang, & Levesque-Bristol, 2019).

One of the autonomy enhancing instruction forms is inquiry-based learning, which has been shown to be highly effective in academic context, since it allows the students to engage in a professional research cycle. Nevertheless it has been acknowledged that there is a high importance of guidance in the application of the instruction form inquiry-based learning. That is to say if the learners are exposed to an inquiry based learning environment without guidance it might lead to confusion and frustration which in turn might even decrease learning outcomes. Therefore it is important to guide the learners through the process of inquiry learning (Jong, 2006).

One way to guide the learners through the inquiry process has been introduced by Jong (2006) and his suggestion to make use of computer-based learning environments as a tool. Additionally it has been established that gamification elements in education might have an impact on motivation and therefore on learning outcomes as well (Buckley, & Doyle, 2014). As previously mentioned narrative systems such as storytelling in the educational context does seem to have an influence on motivation and learning outcomes. Students create a cognitive representation of the given narrative situation and have better cause and effect relations in their cognitive representations (Lindgren, & McDaniel, 2011).

Nevertheless *storytelling* has not been included into an inquiry-based learning process in an online learning environment. Accordingly this study will analyze the influence of gamification elements on motivation and learning outcomes focusing on the gamification element storytelling.

Storytelling connects the learning experience of the students with the context and gives the learning situation a reasoning. The learner is tempted to engage with the learning experience to a higher degree (Toda et. al., 2019). Storytelling is expected to decrease anxiety, increase probability of success, challenge and interest and with that increase the learners motivation (Rini et. al., 2020; Bury, 2019; Baldwin, & Ching, 2016; Freeman, & Burkette, 2019). Next to that the usage of an online environment ensures guidance through the inquiry-process and decreases confusion and frustration (Jong, 2006).

The relationship between storytelling, motivation and learning outcomes has previously been investigated by Reisch (2022) as well. In his thesis he analyzed whether there is an influence of storytelling in an IBL online environment on learning outcome and motivation. For this he established an IBL environment in an online learning environment with two conditions, one of which includes the gamification element storytelling and the other does not. However his results indicate no significant relationship between motivation, learning outcome and storytelling. Hence the current study will be a replication of it with the same IBL online environment, however some alterations have been made in the environment to improve the quality of the study (Reisch, 2022). Previously there have been some questions in the posttest which could not have been answered with the use of the environment. Next to that there was missing information for the learners in order to gain sufficient knowledge from the environment, these have been added to the environment.

The research question for the current study which will be answered is “Can the gamification element *storytelling* increase motivation and learning outcomes of students in higher education in an online inquiry-learning environment?” by accepting or rejecting the following hypotheses:

H1: Participants who engage in the gamification condition with storytelling will have lower levels of anxiety than the participants in the control condition.

H2: Participants who engage in the gamification condition with storytelling will have higher levels of interest, than participants in the control condition.

H3: Participants who engage in the gamification condition with storytelling will have higher levels of probability of success than participants in the control condition.

H4: Participants who engage in the gamification condition with storytelling will have higher levels of challenge than participants in control condition.

H5: Students who engage with the IBL online environment with the gamification element *storytelling* will have higher motivation than the students who did not engage in the IBL online environment with the gamification element *storytelling*.

H6: Students who are exposed to the condition with *storytelling* in the IBL online environment will have better learning outcomes than students who are not exposed to a gamification element.

Methods

Design

The current study was a between-subject design with a one time assessment in order to compare the two conditions ; gamified and non-gamified IBL online environment. Further within-subject measures were also considered due to the development during the study. The

dependent variables were motivation and learning outcome and in the independent variable was the learning environment. Additionally this study received ethical approval to be executed by the Ethical Committee of the Behavioural, Management and Social Sciences at the University of Twente (UT).

Participants

In total 109 participants have been acquired, nevertheless a total of 66 participants had to be excluded from the analysis due to incomplete participation. Thus 43 participants' results have been incorporated in the analysis, randomly divided between the two conditions of the IBL online environment, with the control group incorporating 21 participants and the experimental group 22 participants.

The mean age of the participants was 21 years. About half of the participants have been male 48% and the other half female 52%. Most of the participants are German 95% and the other 2% are from other countries.

Materials

For the data collection a program called *graasp.eu* (Graasp n.d.) was used. This program serves as a tool-kit to create online inquiry learning environments for data collection in studies. For questionnaires the graasp environment offers Questionnaire tools and more tools to use such as "Hypothesis Scratchpads" and also videos can be included. This enables the researchers to use a wide range of methods for data collection. With this program two versions of an inquiry cycle have been created. Two conditions need to be used for the data collection and the comparison between gamified learning environments and non-gamified. In the learning environment the participants were exposed to the teaching of pulley systems and had to follow through the inquiry-process.

The two versions of the inquiry-learning cycles distinguished as one version incorporates the gamification element storytelling. This version contained a storyline explaining the issue at hand with the use of a protagonist named “Laura” explaining their problem and asking the learner for help to solve the problem(Appendix C). The control condition did not incorporate a storyline, the presented problem is formulated neutrally (Appendix D).

The learning environment consisted of the elements of the inquiry cycle, thus the participants had to go through *Orientation, Conceptualization, Investigation, Conclusion* and *Discussion*. However, two more phases have been added, one of which is for the knowledge posttest and the other one to measure their motivation both have been added to the end of the cycle.

Furthermore the phase *Conceptualisation* has been divided up into *Demonstration* and *Combination*. The decision for separation has been made since the participants will have to watch videos in both phases and when they are put together, they might lose their concentration. When they are exposed to solely watching videos without actively engaging, it might decrease motivation as active engagement is crucial according to SDT to ensure need-fulfillment and motivation (Kim, & Castelli, 2021).

The assessment of the participants’ motivation was executed with the Questionnaire for Current motivation (QCM) prior to engaging in the environment and afterwards as well. This serves as a comparison within the subject to assess the difference in motivation before and after participation. Additionally the results serve as a measurement tool for the difference between the two conditions. This questionnaire ensures to assess current motivation as it is known that although a person might be overall motivated for academic achievement, their current motivation can vary . It is a self-report questionnaire with 18 items, which have to be answered on a 7-point

Likert scale with 1 being “not agree at all” and 7 “completely agree” (Rheinberg et. al., 2001) (Appendix E).

In the *Evaluation* phase of the environment, a knowledge posttest was provided to the participants which assessed their learning outcome after the participation. A total of nine questions were presented, accordingly the participants could get a total of nine points. Eight open questions were proposed and one multiple choice question (Appendix F). The proposed questions assessed the knowledge the participants could gain while engaging in the environment therefore domain specific questions are asked (How is the pulled rope length related to the height lifted?). The results of the knowledge posttest enabled the assessment of the learning outcome for each condition and enabled the comparison between the two conditions.

Procedure

The data collection for the study occurred in two ways. One way has been with the use of the Sona Systems from the University of Twente, in which the students signed-up for participation by choice. With a successful participation the students who signed-up, received one credit point as a form of reward.

Another method to advertise the study was to send the link to people in the researcher's environment which meet the requirements for participation, which is to speak and understand english and be a student from higher education. Independent from the acquisition of the participants, each of them received a link with which they had access to the online learning environment.

After the participants follow the link they have been asked to give a nickname after which the learning environment started. At first the participant had to give their consent if they are willing to participate in the study and if they accept the circumstances. Afterwards some

demographic questions were asked such as age and their origin. Following that the participants had to answer some questions regarding prior knowledge and they have to fill out the QCM as a pretest. This aims to have data for comparing whether the IBL online learning environment has an influence on the motivation of the participants.

After that the learning experience started and the participants went through the inquiry cycle step by step. In the *Evaluation* phase of the inquiry cycle the participant had to complete a knowledge posttest, which assessed their acquired knowledge after completing the cycle. And lastly, the participants had to fill in the QCM posttest, which assessed their current motivation again. Depending on their own pace the participation took about 30-45 minutes.

Data Analysis

At the end of the data collection, the results were reviewed on graasp.eu for incompleteness and other factors for exclusion. The collected data was first extracted and manually transferred into an Excel document.

The extracted data consisted of the learning outcomes and the level of motivation grouped according to the four scales in the QCM. The learning outcomes have been scored with correct (1), partially correct (0.5) and incorrect (0) as suggested by Reisch (2022). A sum score has been calculated based on the given scoring and has been put in a data matrix. The QCM results were summed up and the average score has been calculated per scale, resulting in the comparability of the pre-and posttest results for each scale. These have also been put into a data matrix for further analysis.

Afterwards the data has been imported into R. R serves as a statistical environment offering tools for the analysis of various data. For the current study version 4.2.2 released on 31 October 2022 has been used (R, n.d.). After the data has been imported into R boxplots have

been used to visualize the data. Afterwards it has been analyzed to investigate the aforementioned hypotheses.

To investigate motivation of the participants paired t-tests or the Wilcoxon signed rank test has been executed, to analyze the development within a condition. And for the analysis between conditions similar tests have been run which then are unpaired or called Wilcoxon rank sum test. To assess the differences between the two conditions, first the pretests have been compared to assess whether there are significant differences between the groups before performing in the learning environment, afterwards the posttest have been compared. The learning outcomes of the groups have also been analyzed with Wilcoxon rank sum test to compare the groups. To be confident about the normality, independence of observation, homogeneity of variances, fitting variables and no strong outliers the statistical assumptions have been assessed.

Results

Assumptions

The statistical assumptions for independence of observation was not violated as the participants did not know that two different conditions of the environment exist and that the measured variable is the gamification element *storytelling* as deception has been used.
With the use of boxplots extreme outliers for three of the four scales were detected. Therefore the assumption for equal variances has been violated. Lastly, all measures violated the assumption for normality, which has been detected by visualizing the distribution with histograms. As a result the Wilcoxon rank sum test (or Mann-Whitney U test) for the unpaired/independent observations and for the paired/dependent observations the Wilcoxon signed rank test has been used as they serve as non-parametric test to compare groups.

Motivation

Table 1

Mean scores and Standard deviations of the QCM (n=43)

Condition	Gamification			Control- group		
	Pretest	Posttest	Difference	Pretest	Posttest	Difference
Anxiety	2.65 (1.46)	2.72 (1.37)	0.07	3.9 (1.3)	3.5 (1.83)	-0.4
Interest	3.45 (1.76)	3.63 (1.65)	0.18	3.37 (1.53)	3.29 (1.69)	-0.08
Challenge	4.42 (1.62)	4.44 (1.75)	0.02	5.01 (0.75)	4.45 (1.39)	-0.56
Prob. of Success	2.93 (0.89)	2.98 (1.13)	0.5	3.49 (0.76)	3.18 (0.88)	-0.31

As mentioned above, the QCM measures motivation with four scales which are *Probability of Success*, *Interest*, *Challenge*, and *Anxiety*. The mean values for each scale shows the results for the scales before and after the engagement in the IBL online environment (Table 1).

The analysis of the pretest results between the groups indicated a significant difference in *Anxiety*. Participants from the gamification condition scored lower in *Anxiety* than participants from the control condition $W = 113.5$, $p = .004$. A further significant difference before the start of the environment could be seen in the scale for *Probability of Success*. Participants in the gamification condition had a lower score in perceived *Probability of Success* than participants in the control condition at the start of the IBL online environment $W = 148$, $p = .04$. The difference in the other two scales showed no significant difference between the two conditions, although a

slightly lower level of *Interest* and *Challenge* could be observed for the gamification group (W = 235, p = .922; W = 199, p = .434).

Since the previous analysis revealed a difference in the pretests between the two conditions, it has been decided that the difference values of the pre and posttest per condition will be compared. Hence the differences between the pre and posttest per condition has been calculated. These values have been analyzed with the Wilcoxon rank sum test. The results revealed a non-significant difference between the control condition and the gamification condition in the *Anxiety* levels W = 300, p = .172. Although the *Anxiety* levels for the control group were slightly lower than in the gamification condition, this was statistically non-significant.

The boxplot for the visualization of the comparison in *Interest* between the groups showed no difference between the groups. The Wilcoxon rank sum test showed the level of *Interest* was slightly lower for the control condition, however these results were non-significant W = 275, p = .435. The level of *Challenge* was slightly higher for the gamification condition, however these results were non-significant as well W = 193, p = .247. The visualization for the measurement of *Probability of Success* indicated no difference between the groups. The Wilcoxon rank sum test revealed that the control condition had lower levels for the scale *Probability of Success*, however these differences were non-significant W =275, p = .435 (Table 2).

The within-group Wilcoxon signed rank test in the gamification condition for *Anxiety* showed a non-significant increase after the participation V = 85.5, p = .477. Similar results could be observed for the measure of *Interest*, although there was a slight increase it was non-significant V = 81.5, p = .878. The within-group measure for *Challenge* indicated a

non-significant positive development $V = 83$, $p = .930$. The measure for *Probability of Success* revealed a non-significant increase after the participation $V = 83$, $p = .930$ (Table 1) (Appendix A).

The within-group analysis for the control-condition also indicated non-significant developments between the moments of measurement. The Wilcoxon signed rank test for *Anxiety* revealed a non-significant decrease between the measurements $V = 135.5$, $p = .262$. Further it showed that *Challenge* had a non-significant decrease after the participation $V = 146$, $p = .128$. Similar results have been observed for the analysis of *Interest* ($V = 92.5$, $p = .463$) and *Probability of Success* ($V = 115$, $p = .202$) as there was a slight increase for both but both being non-significant (Table 1) (Appendix B).

Table 2

Mean values of the Differences between the Pre- and Posttest of the QCM per Condition (n=43)

Condition		
Scale	Gamification	Control-Condition
Anxiety	0.07 (1.53)	-0.38 (1.43)
Challenge	0.02 (1.27)	-0.53 (1.47)
Interest	0.31 (1.63)	-0.08 (1.06)
Prob. od Success	0.05 (1.06)	-0.27 (0.8)

Learning Outcomes

When comparing the learning outcomes of the participants between the groups boxplots have been created which visualize the data. It could be seen that there is no significant difference between the two conditions. Similar results have been found with the unpaired Wilcoxon rank sum test. The test and the visualization revealed that the participants from the control-group had

slightly better learning outcomes than in the gamification condition $W = 242$, $p = .1$, however this difference was statistically non-significant (Table 3).

Table 3

Mean scores and Standard Deviations of the Knowledge Posttest (n=43)

Condition	Gamification	Control-Group
Learning-Outcome	3.89 (2.41)	3.95 (2.21)

Discussion

This study investigated whether there is an influence of gamification in IBL online environments in higher education students on their motivation and learning outcomes. The proposed research question for this study has been "Can the gamification element *storytelling* increase motivation and learning outcomes of students in higher education in an online inquiry-learning environment?". To be able to answer this question two hypotheses have been made which will be discussed in the following section.

Motivation

The first hypothesis stating that participants who engage in the gamification condition including the element *storytelling* will have lower levels in *Anxiety* compared to the participants in the control condition is rejected. The results show that there is a slight tendency that the participants in the control condition have lower levels of *Anxiety,* however these results are not significant. This could be an indicator of an existing relationship, which could not be investigated in the current study.

Furthermore it is important to note that the participants from the two conditions started the IBL environment with significantly different *Anxiety* levels. The control condition started the

IBL environment being higher in *Anxiety* and slightly decreased in *Anxiety* after the participation, whereas the participants in the gamification condition started being lower in *Anxiety*, but slightly increased in *Anxiety* after the participation, which is an unexpected development. Especially since past research indicates that the usage of the gamification element *storytelling* has the effect of decreasing anxiety levels in the academic context, especially in test situations. However Pitoyo and colleagues mention that the most influencing gamification elements are different to the used one in the current study, which might be the explanation for the differing results (Pitoyo et. al., 2019).

The second hypothesis has to be rejected as well, which assumes that the participants from the gamification condition will have higher levels of *Interest* compared to the control condition. Previous studies show that there is a relationship between increasing interest and learning outcome with narratives in online learning environments, however the current study cannot confirm these results completely (Lindgren, & McDaniel, 2011). Although an increase in *Interest* can be observed between the pre and posttest results from the gamification condition, these results are not significant. Additionally, there is no difference between the groups which would indicate a relationship between *storytelling* and *Interest*. Nevertheless in the control group it could be observed that *Interest* decreased after participation, whereas it increased in the gamification condition, but as mentioned earlier these differences are statistically not significant, but serve as an indicator for future research.

Similarly the third hypothesis stating that the *Probability of success* levels will be higher for the gamification condition compared to the control condition is rejected as well. Although the control condition has a non-significantly lower level of *Probability of Success,* a decrease is experienced, but in the gamification condition the measures stay more stable and no decrease has

occurred. In the gamification condition there is almost no change between the two measures before and after participating in the IBL environment.

Probability of Success is a similar measure like autonomy and competency in the SDT, and the results indicate that the research executed by Hsu, Wang, and Levesque-Bristol can be partially confirmed (Hsu, Wang, & Levesque-Bristol, 2019). According to their article autonomy enhancing instruction forms can fulfill the three psychological needs, which in turn increase motivation and as the results do not show a decrease in *Probability of Success* but a non-significant increase after participation and additionally a decrease in the control condition after participation. However as these results are statistically not significant there needs to be more research in this field.

Lastly the fourth hypothesis assuming that *Challenge* will be higher in the gamification condition has to be rejected. Although slight differences in favor of the hypothesis can be observed, these results are statistically not significant and cannot be generalized and applied to the population of higher education students. These results might indicate that tha proposed IBL online environment has been too complicated for the participants. As explained bei Rheinberg and colleagues (2001), the demands of the task should not be too overwhelming for the learner to achieve the right amount of challenge that prevents the learner from frustration (Rheinberg et. al., 2001). Also the fact that a large rnumber of participants quit the IBL online environment is an indicator for an insufficient learning environmen, which is too complex and causes frustration and demotivates the participants.

As each hypothesis of the scales from the QCM has to be rejected, the hypothesis that people from the gamification condition are higher in motivation than the participants from the control condition has to be rejected as well. Overall, statistically there are no significant

differences before and after participation within the groups. Additionally there are also no significant differences between the groups in the posttests or in the difference means. However for the gamification condition the measures stayed more stable. There have been less differences before and after the participation but for the control condition the measuress have had slightly more differences, although both being non-significant.

These non-significant differences between and within the groups are unexpected due to the amount of research which shows a relationship between motivation and gamification elements. One possible explanation for these unexpected results could be the sample size. This study had 43 participants, which could represent two classes compared with each other. However since the statistical assumptions have been violated and only non-significant differences could be established the sample size seems to be insufficient.

Furthermore, the overall motivation level of the participants rather low which might be due to the general unmotivated attitude towards learning. As Tohidi and Jabbari mentioned in their article, already after the second year in school students' motivation in the academic environment decreases and if this unmotivated attitude continues throughout their academic career, it might be harder to find methods to change this underlying demotivated attitude (Tohidi, & Jabbari, 2012). Accordingly, it might be interesting to investigate the same study with students in elementary school and with a bigger sample size to measure the relationship between motivation and the gamification element *storytelling* for a younger age range. Additionally this could be compared to the a higher age range to measure differences.

Another reason for the discrepancy between previous studies' results and the current study is that the previous studies mostly incorporated more than one gamification element. This might be an influencing factor as it might seem more "game-like" with more than one

gamification element. Possibly the influence of a number of gamification elements is higher than the one of a single gamification element as other studies show (Pitoyo et. al., 2019).

Learning outcomes

The last hypothesis stating that the gamification condition will result in better learning outcomes as a result of increased motivation is rejected as well. As the analysis shows the learning outcomes for the control condition are slightly better than in the gamification condition, but these differences are small and non-significant, which is an unexpected result. Mainly, the results of the knowledge posttest are low for both groups indicating that the given knowledge posttest might have been too difficult. As the article of Jong indicated, an IBL environment should be well guided and monitored, otherwise it could lead to confusion and even hinder the learning process of learners. Accordingly, the reason for the bad learning outcomes could be that the IBL environment was not supportive enough during the learning process which might have caused confusion and frustration (Jong, 2006).

Since the participants are also low in their motivation, their learning outcomes might have been influenced by that as well, as this study is based on the assumption that intrinsic motivation is a strong indicator for better academic performance (Tohidi, & Jabbari, 2012).

It seems that this IBL online environment does not support the participants in their learning process. A large number of participants quit the learning environment after a few phases and they did not complete it. This might indicate that the learning environment itself is poorly constructed and not suitable for this study. Studies show that the use of IBL is not suitable if the task is too difficult for the learner. For more complex tasks more teacher guidance would be needed (Bruder, & Prescott, 2013). Therefore it could be that the IBL online environment is constructed too complex or it lacks guidance.

Strengths and Limitations

This research paper provides an insight into the possibilities of online learning environments and the relationship between the gamification element *storytelling*, learning outcomes and motivation. The results indicate a possible relationship, although they are non-significant. The mere fact that there are a number participants who did not complete the environment creates space for further research in this area.

Nevertheless this study has a variety of limitations. As mentioned before the sample size is insufficient. Although it could be a representation of two comparable classes, it is apparent that the results of the analysis with this sample size is not generalizable and applicable to other higher education students. Therefore the results of this study are not reliable.

Additionally the number of participants who quit the study indicates that the created IBL online environment is low in quality. The assumption that the environment was too difficult is apparent. This again decreases the reliability of the study.

Lastly a few participants reported technical issues with the used website graasp.eu. Video learning materials could not be opened and viewed by the participants, which hindered their learning process.

Recommendations for Future Research

The importance of online education is highlighted by the requirements in recent times. Four years ago the importance has not been as noticeably as it has been the last three years. Accordingly more research is needed in this field to fully investigate the best instruction forms which can be offered in online environments.

This paper shows that motivation in online education is difficult to establish. Numerous participants quit the participation either because the environment lacks in quality, or their

motivation is not high enough to follow along in an inquiry-cycle. Both reasons indicate a challenge for the creation of a sufficient learning environment which incorporates the learner in such a way that they are motivated to further engage in the environment.

The current study showed no difference between the condition of a non-gamified and gamified environment using the gamification element *storytelling,* nevertheless this relationship should be further studied as previous studies revealed that there is an existing relationship (Lindgren, & McDaniel, 2011). Narratives do seem to increase interest and even enhance critical thinking.

Additionally other gamification elements should be investigated separately. Most studies examined the influence of gamification elements on learning using more than one gamification element (Pitoyo et. al., 2019). However these results do not reveal the most influential gamification element or if the constellation of numerous gamification elements are crucial.

Lastly the investigation in different age ranges and the comparison between them might also be important. Due to the fact that the motivation levels for academic engagement decreases after the second year of elementary school, a comparison between different age ranges might reveal how this decrease could be avoided by actively enhancing the students' motivation with suitable instruction methods. If it is known how students' intrinsic motivation can be increased in online learning environments with gamification elements the learning process of students is supported and the decline in motivation for academic engagement can be avoided (Tohidi, & Jabbari, 2012).

Conclusion

Summed up, this study cannot confirm the results of various past studies that there is a relationship between the gamification element *storytelling* and motivation in IBL online

environments. However the results of the current study are not generalizable and applicable for the population of higher education students. The sample size of the study is insufficient. The research question “Can the gamification element *storytelling* increase motivation and learning outcomes of students in higher education in an online inquiry-based-learning environment?” can be answered as there is no significant relationship between storytelling, motivation and learning outcome in this study. Since a number of other studies resulted in a relationship between gamification, motivation and learning outcome, it is important to further investigate this relationship. Especially since the recent events showed the increasing need for online education.

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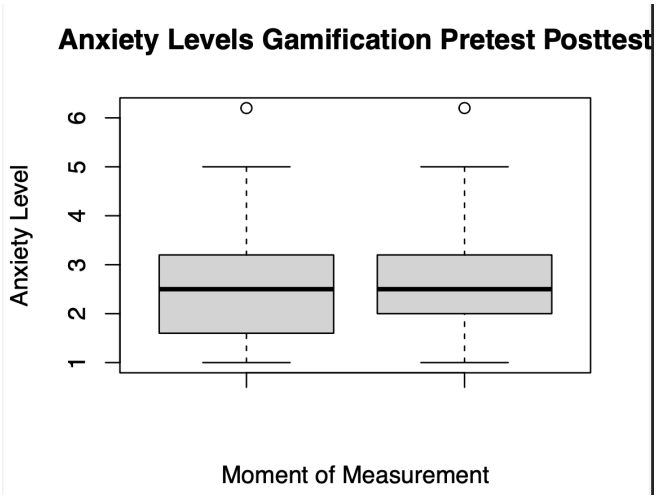
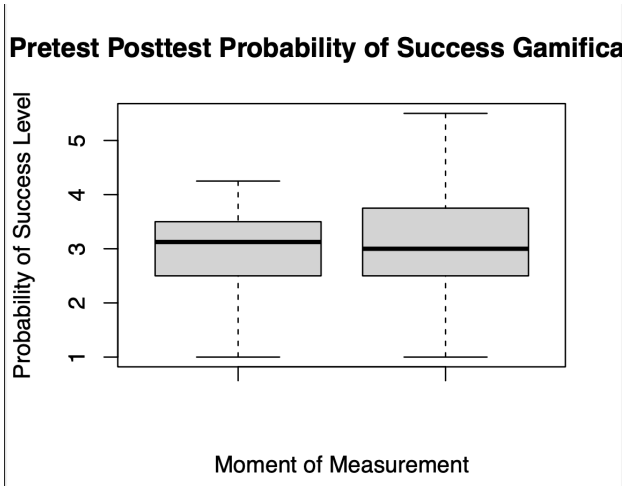
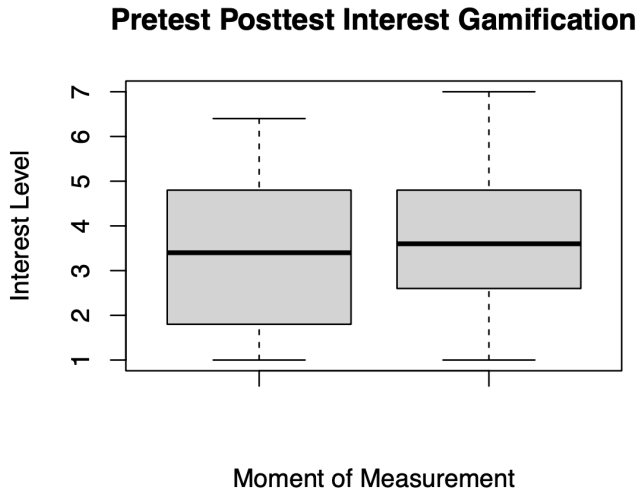
Appendix

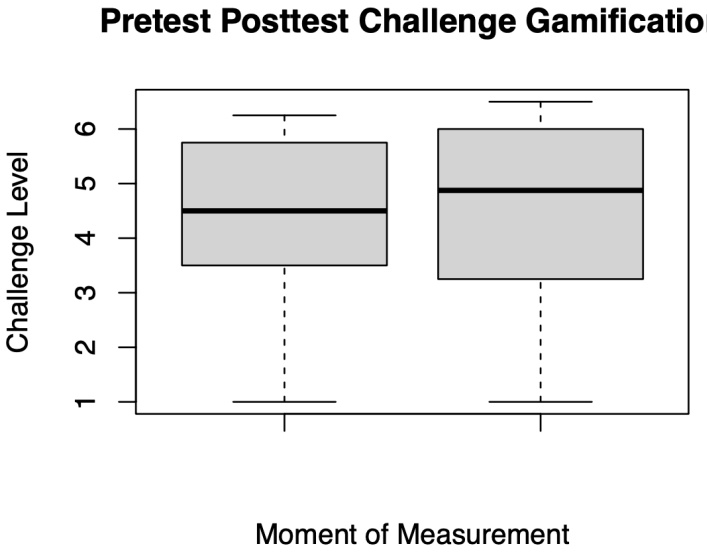
Appendix A

Comparison Pe-and Posttest Gamification



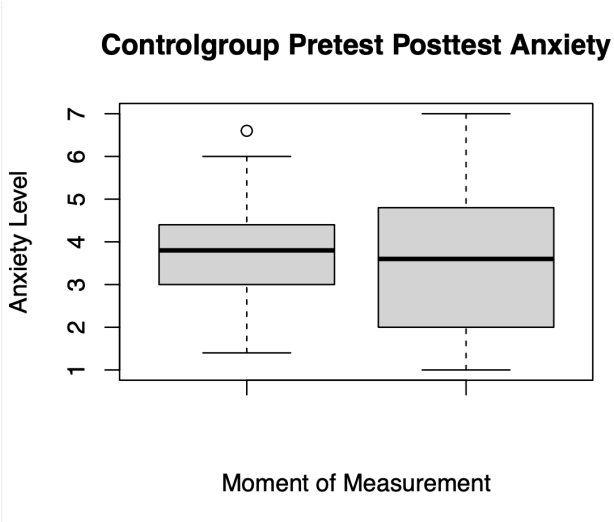

Pretest Posttest Probability of Success Gamifica
Probability of Success Level
1
2
3
4
5
Moment of Measurement

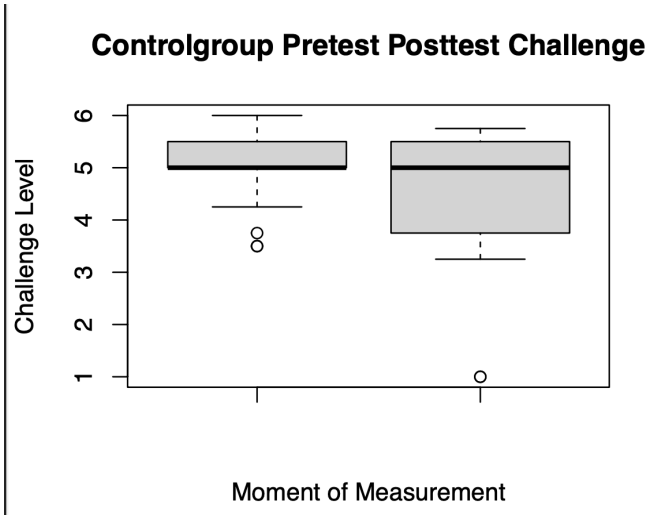

Pretest Posttest Interest Gamification
Interest Level
1
2
3
4
5
6
7
Moment of Measurement

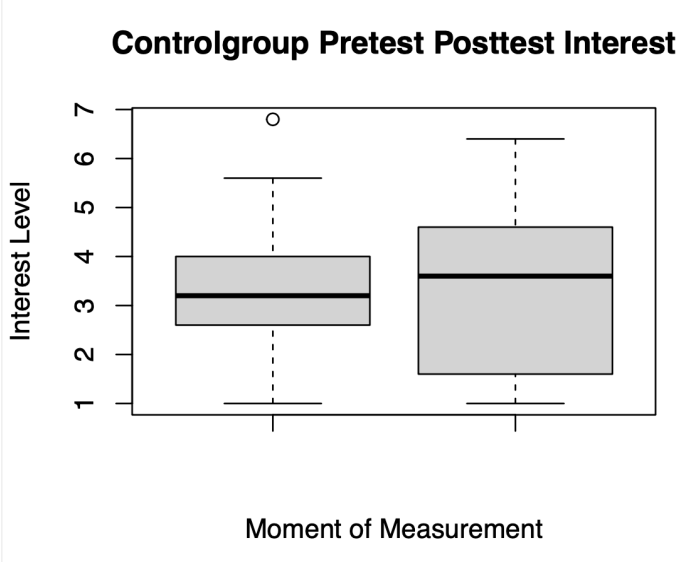

Pretest Posttest Challenge Gamification
Challenge Level
1
2
3
4
5
6
Moment of Measurement

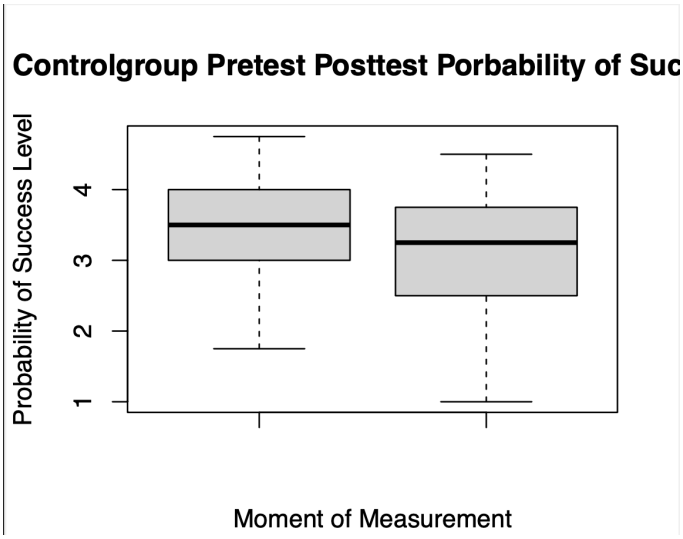
Appendix B

Comparison Pre-and Posttest Control Group









Appendix C

Gamification Condition

Laura has been studying in Enschede for the last three years. A few weeks ago she finished her bachelor thesis and now she wants to move to Amsterdam to complete her master. After spending a lot of time and effort looking for a room, Laura has finally received the confirmation from a landlord to live in his flat in the city center. Laura is thrilled and wants to get started moving right away. Unfortunately, most of her friends and family have to work, but she decided to go anyway.

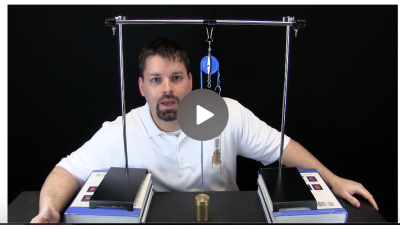
The next day, she hires a truck and drives to her new home. Her best friend Lucy also joined Laura to help out. When meeting the new landlord inside, they notice how steep and tight the staircase leading to her flat in the third floor is. Laura is doubting that her couch can fit through the staircase and thinks about other ways of lifting the couch into her flat. They are frustrated that they cannot just get started. Everything was going so well and now they do not know what to do.

Laura remembers her grandfather talking about using a pulley. Before driving to Amsterdam, he gave Laura a box with a long rope and several wheels and told her that she might find it useful.

Click demonstration on the left to move on to the next phase.

Laura, who has never used a pulley is confused. How are these rusty wheels and the rope going to solve her problems? She pulls out her smart phone and finds the following video about pulley systems and what they are good for.

Watch the video and afterwards indicate on the hypothesis scratchpad how you believe the elements to be related. Give at least 3 hypotheses and indicate how confident you are in the hypotheses, by adjusting the blue bar on the right hand of the environment.



Consent & Information
Introduction & Briefing
Orientation
Demonstration
Combination
Investigation
Conclusion
Discussion
Evaluation
Perception

Terms

IF THEN increases decreases stays the same
changes is larger than is smaller than is equal to
is not equal to required force pulled rope length
distance lifted number of pulley elements effectiveness
weight lifted [type your own]

Hypotheses

Drop and arrange your terms here.

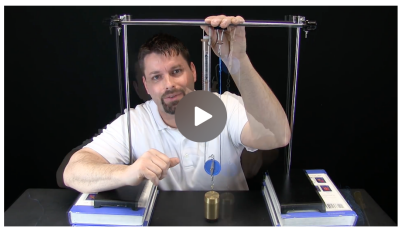
Drop and arrange your terms here.

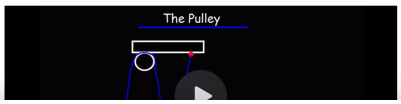
Drop and arrange your terms here.

Laura starts to understand what her grandfather was trying to tell her. She continues to watch the video to figure out more about the use of multiple rope and pulley elements.

Watch the second part of the videos to get a better description on how pulley systems work.

After finishing the two videos, move to Investigation phase.





Laura found this application on the internet. To gain an idea about the efficiency of pulley systems, follow the simulation and experiment with various pulley systems and compare how they vary from each other. Examine the system and consider the following aspects:

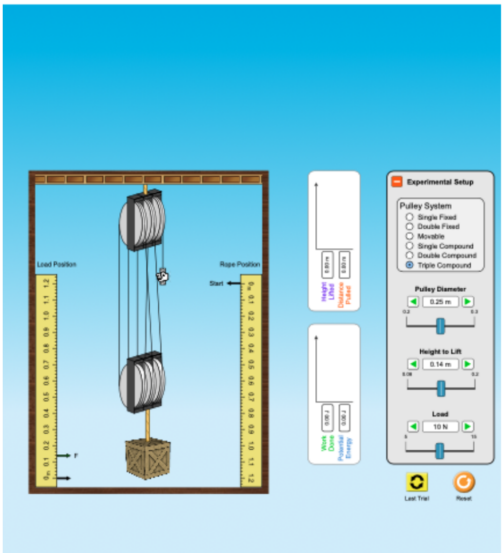
Which of the six pulley systems is the most effective, which the least?

How does the required force adapt to the changes between the systems?

What is the relationship between the number of pulley elements and the load required to lift?

How does the integration of multiple pulley elements affect the distance pulled?

Below, you will find a short instruction and the simulator. Here you can explore the pulley systems.



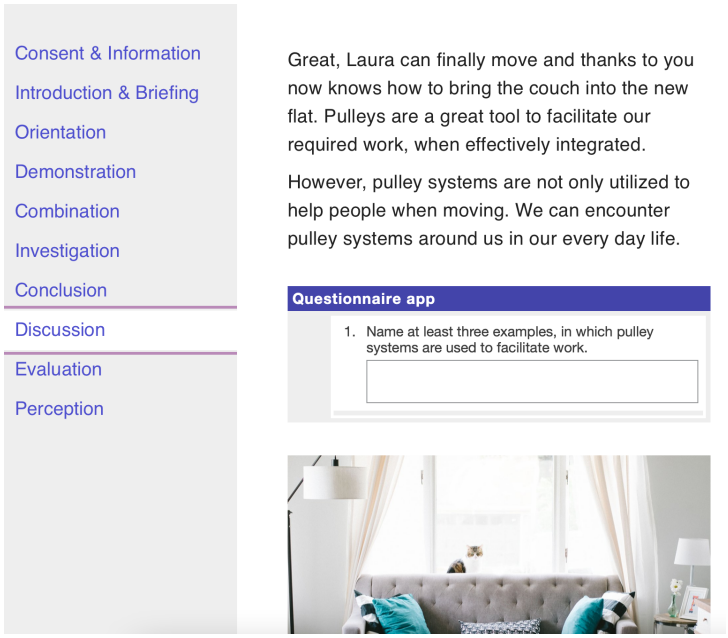
Laura still needs to move her massive couch through the window (8 meters high) into the 3rd level of her new flat. She could use each form of the pulley systems from the previous simulator. Right now, she has 25m of rope and a maximum of six pulleys are available, which her grandfather gave to her. Imagine the couch weights around 200 kilogram and Laura can lift a maximum of 55 kg. Her best friend is upstairs and will help to lift the couch through the window.

Can you help Laura with her problem? Give your answers below and continue with the discussion phase.

Questionnaire app

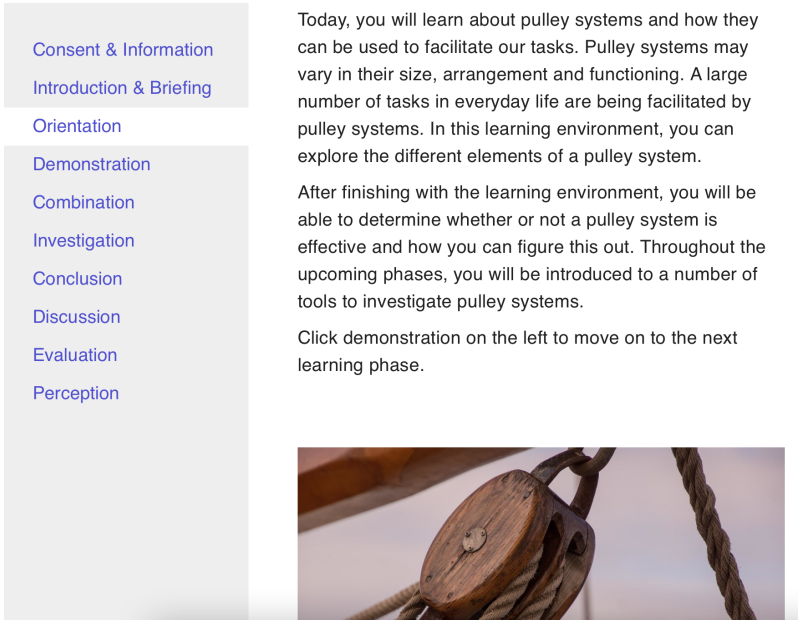
1. What suggestions can you give to Laura to move her belongings inside the new flat?

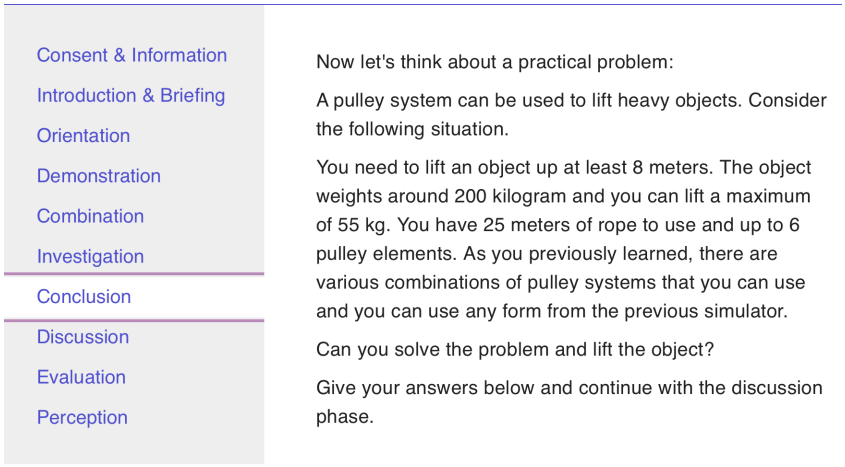
2. Would Laura succeed to lift up the couch all the way? Explain, how you came to your conclusion.



Appendix D

Differences in the Control Condition





Appendix E

The Questionnaire of Current Motivation (measuring on a 7-point Likert scale)

1. I like to partake in experiments.
2. I think I am up to the difficulty of the task.
3. I probably won't manage to do this task.
4. While doing this task I will enjoy playing the role of a scientist who is discovering relationships between things.
5. I feel under pressure to do this task well.
6. This task is a real challenge for me.
7. After having read the instructions, the task seems to be very interesting to me.
8. I am eager to see how I will perform in the task.
9. I'm afraid I will make a fool out of myself.
10. I'm really going to try as hard as I can on this task.
11. For tasks like this I don't need a reward, they are lots of fun anyhow.
12. It would be embarrassing to fail at this task.
13. I think everyone could do well on this task.

14. I think I won't do well at the task.
15. If I can do this task, I will feel proud of myself.
16. When I think about the task, I feel somewhat concerned.
17. I would work on this task even in my free time.
18. I feel petrified by the demands of this task.

Appendix F

Knowledge Posttest Questions

1. What do you know about pulley systems?
2. Which unit is used to measure physical force?
3. Which unit is used to measure physical force?
4. How is the pulled rope length related to the height lifted?
5. How can the required force be calculated?
6. Which system is more effective? The double fixed or the double compound system and how big is the difference in efficiency? Why?
7. With which components can the *work* be calculated?
8. Which unit is used for *work?*
9. What does a pulley do in order to make life easier?
    1. Decreases the amount of work that needs to be done to lift the object
    2. Decreases the needed force to lift the object by changing the distance
    3. Increases the amount of work that needs to be done to lift the object
    4. Increases the needed force to lift the object changing the distance