Empirical Evaluation of the Impact of Game Elements on Reflection as a Learning Tool for University Students of the Subject of Research Methodology

Olga Karageorgiou

Department of Psychology, University of Twente

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Dr. Judith ter Vrugte

Loes Hogenkamp

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Abstract

In the last decades, the industry poses pressure on higher education institutions to prepare their students for the future job market differently. Currently, the students simply obtain knowledge as this is offered by their educators. However, the industry requires that the students become skilled in adapting any innovations in their field as they rapidly occur in each field. This tendency in the job market pushes educators to find approaches to develop their students' self-directed learning. To address this demand educators, consider reflection as the most suitable solution. However, students often do not comprehend the relevance of reflection to their academic carrier and are not able to deeply reflect on their immediate and long-term actions. To overcome similar barriers in student engagement and quality of work educators incorporate gamification in their instructional methods.

The present study evaluated the hypothesis that gamification could improve the quality of the reflection of university students. To test this hypothesis a quasi-experimental study on reflection of learning goals during tutorials on Research Methodology was conducted. The experiment consisted of two conditions, both of which offered the same reflection, with the only difference being the incorporation of game elements in the experimental condition. Contrary to the hypothesised outcomes, the students in the experimental condition attained lower-level reflections than the ones in the control condition. The limitations detected in the current study, serve as a warning for a more balanced connection between game elements utilization and reflection practices. Based on the overall study outcomes, it can be inferred that to enhance the quality of reflection the educators should ensure a) understanding of the personal value of it in students' carrier and its immediate gratification, and b) simplicity and clarity in instructions, and incentive for interaction to allow lower cognitive load.

Empirical Evaluation of the Impact of Game Elements on Reflection as a Learning Tool for University Students of the Subject of Research Methodology

In the last decades, there seems to be a constant development in the job market regarding the skills that employees are expected to obtain (Toh & Kirschner, 2020). The industry demands that educational institutions equip their students with more than content knowledge regarding the current developments in the industry (Saabye et al., 2022). They rather expect higher-order thinking and metacognitive skills, that can assist students to deeply comprehend the latest novelties in knowledge, monitor their learning and adapt their skills to their future careers (Okoro, 2011; Zimmerman, 2002). This ability to actively involve in the reflection of one's own learning skills and to adapt those to the needs of any new environment without necessarily following an education termed self-directed learning (Yang et al., 2019), is what the industry demands from higher education institutions (Toh & Kirschner, 2020). Those same higher-order thinking and metacognitive skills are naturally also necessary in academia, especially regarding the epistemic disposition of the students, where learners need to shape an understanding of how they acquire knowledge for scientific inquiry (Yang et al., 2019).

To reach that level of self-directed learning where the students believe that they can steer the acquisition of knowledge independently they need to learn how to learn, how to work unattended and become masters of their own progression in their careers (Saabye et al., 2022). This level of autonomy can be achieved by consistent evaluation of one's work, known among teachers as reflection (Esch, 1996). However, educators often face challenges in motivating their students to deeply evaluate their learning (Cavilla, 2017). Lack of understanding of reflection's usefulness and applicability appears to be the main reason that leads to students' disengagement or superficial completion of reflections (Leijen et al., 2020).

To increase engagement, it is necessary to incorporate some methods that would increase motivation and self-confidence by shifting the attention from the goal to the process without losing sight of the long-term goals of reflection. To reach those advantages in similar situations teachers applied gamification, or the utilization of game elements for educational purposes (Wang, 2022). The shift of attention towards the process, the personalization to one's own learning needs and the focus on the journey's enjoyment rather than the end goal were advantages that the educators could harvest by adding game elements to their teaching material (Hamari et al., 2014). The question, hence, raises as to whether the use of gamification could improve students' reflection quality by offering an understanding of how to autonomously evaluate one's progression in favour of advancing in their future careers.

Reflection

Future employees are expected to be able to comprehend which information is more relevant to their work and independently direct their development accordingly (Okolie et al., 2019). A method that many educators have utilized over the years to promote self-directed learning is reflection. Reflection can be defined as a means to engage in making sense of experiences in situations that are rich and complex and which do not lend themselves to being simplified by the use of concepts and frameworks that can be taught (Boud & Garrick, 1999; p.4).

To make the complex process of reflection more tangible, it can be broken down into two basic steps that can be followed by the students individually or with the guidance of their educators. The first step is evaluating one's own work (Lousberg et al., 2019). This awareness of one's learning approach requires active, regular and critical examination of their actions (Dewey's, 1933, as cited in Uştuk & De Costa, 2020), as well as a sense of ownership and accountability for their development (Vygotski's, 1997, as cited in Uştuk & De Costa, 2020). To reach this step the development of cognitive skills (Wisniewski et al., 2020) and

critical thinking are required (Lousberg et al., 2019) since those can support students to evaluate strengths and weaknesses of their approach to learning and application of their newly acquired knowledge in comparison to their intended outcomes (Wirth et al., 2021).

The second step of the reflection process according to Louseberg et al. (2019) is the action of adjusting one's previous thinking strategy for new, more promising approaches, reflecting again the concept of self-directed learning (Chang, 2019). Based on the previously obtained results from the initial reflection, the students can adjust their approach to learning and adopt a different learning strategy (Andrade & Brookhart, 2020). Repeated practicing of adjusting their learning approach by reflecting throughout the school years can lead to the automation of this behaviour for their later employment (Fiorella, 2020).

Continuously repeating the two steps of reflection, the students eventually become life-long learners, able to assess and adjust their learning approach in accordance with the demands of any new environment, academic or work-related (Hill et al., 2020). However, it is important to recognize that not all working and learning settings have identical demands. Therefore, a variety of reflection types were developed to cater for the diverse purposes of each environment (Wisniewski et al., 2020). Selecting the most appropriate form of reflection may pose challenges to educators (Lousberg et al., 2019). Hence, proper scrutiny of the different reflection forms is required prior to the application to the learning needs of any environment.

Challenges of reflection

One of the most important distinctions of reflection types is connected to the timing of the reflection in relation to the activity to which it refers (Schon, 1983). Reflection-on-action is the type of reflection that occurs prior or posterior to the activity, and reflection-in-action occurs synchronously to the activity that it connects to (as cited in Uştuk & De Costa, 2020). While reflection-in-action offers direct feedback about the concurrent thought development

of the learner and their thinking processes when automating an activity (Wolcott & Lobczowski, 2021); reflection-on-action requires less emotional and cognitive load and offers a perspective from a higher vantage point on the learner's thinking process (Uştuk & De Costa, 2020). Hence, reflection-on-action could be more suitable when aiming to reach confidence about self-directed learning on tasks long-term and developing life-long learning skills for the job market.

Similarly, the frequency of the reflection offers another distinction. For some activities, reflection takes the form of a single occurrence (Uştuk & De Costa, 2020), or a repeated systematic action (Chittooran, 2015). Long-term learning goals, such as higher-order learning skills, are better reflected through consistent deliberation of a series of reflections (Yang et al., 2019). In this way, the learners receive multiple chances to revise their learning approach and even to test multiple strategies (Chittooran, 2015). On the contrary, simple skill development (e.g., motor skills) can be obtained by a single reflection (Killion & Todnem, 1991). This single reflection occurrence can also be beneficial to achieve an *Aha! Moment*, whereby the learner reaches an important insight (Moroshkina et al., 2022). Hence, such a single reflection could be relevant for deciding on the learning strategy for a subject. The benefits would be long-term, but the insights would be perceived only once.

Furthermore, reflection can also be distinguished into different types based on the level of depth that it requires (Leijen et al., 2020). In this trend reflection can be segregated into *analytical*, whereby a learner superficially analyses the process of learning and doing; and *evaluative*, whereby the user judges the process and its learning outcomes and strategizes towards future learning approaches. More complex processes require higher reflection depth covered by structured curriculum tasks and applied service-learning projects (Chittooran, 2015). On the contrary superficial reflections utilize analytical reflection tools, such as

journal writing and evaluation forms (Marshall, 2019). Thus, to comprehend one's superficial learning activities an analytical reflection type would be more suitable.

Finally, reflection can be adjusted to the curriculum needs of its target audience's characteristics. To reach increased intrinsic motivation educators allow voluntary participation in the reflection activities. This approach leads often to high-quality in-depth reflections since the participating learners recognize the relevance of the reflection activity to their own needs and real-life cases (Chittooran, 2015). An alternative approach, however, is to not offer reflection as an additional activity, but rather as a core graded activity of the curriculum. This approach taps directly into the extrinsic motivation of the students rewarding them for the labour completed (Díaz-Iso et al., 2019). Hence, the intrinsically motivated voluntary reflection would be more relevant when evaluating one own carrier perspectives long-term.

Gamification as a solution to the challenges of reflection as a learning approach

To harvest the previously mapped positive aspects of reflection, while tackling the lack of engagement and its superficial completion, a method needs to be utilized that increases enjoyment, while maintaining focus on the usefulness of the learning activity. A multitude of previous studies demonstrated such increased learner engagement through the implementation of gamification (Chans & Castro, 2021; Hosseini et al., 2022; Kalogiannakis et al., 2021; Wang, 2022). The latter is defined as the use of game design elements and principles in a learning environment (Hamari et al., 2014). When utilizing this approach, the learning settings can be altered to increase competition, pleasure and/ or interaction (Deterding et al., 2011).

Gamification has the potential to support learning by boosting learners' motivation through a multitude of game mechanics, such as progression (Prasad & Mangipudi, 2021; Seifert & Gez, 2021), and aesthetics, such as appealing graphics (Nah et al., 2014). For

instance, through the utilization of points, levels, and badges the users' attention becomes captured to reach a goal and increase gratification by obtaining higher results (Seifert & Gez, 2021). The utilization of those micro-rewarding systems increases the intrinsic motivation of users, hooking them into the game story as it develops. A study by Harrington and Mellors (2021) proves that with outstanding game mechanics and aesthetics the engagement can reach such high levels that the students might forget the original goal of the activity, and rather focus on collecting points, like in a real game. Moreover, the addition of game mechanics such as feedback and progress bars can support the users' self-efficacy, or the belief in the ability of an individual to complete their tasks independently (Polo-Peña et al., 2020). Therefore, game aesthetics and mechanics have the potential to captivate users' attention to a great extent overcoming the original absence of engagement with reflection.

Furthermore, the use of a storyline can support learners' engagement by shifting their attention from the goal to the process of playing. This phenomenon was strongly evident in the study of Belim et al. (2014) where children reported in their reflection to have strong feelings for the avatars of the game and to engage in pro-social behaviour with them regardless of their own initial intentions. Moreover, true engagement with the story can lower the threshold of failure and disappointment and allow the users to fully engage with the activity (Wang, 2022). This was especially prevalent in the study by Kallevig (2017) where university students disclosed to find failure less significant as long as it could contribute to the larger picture of their learning experience. Thus, it can be inferred that when individual tasks are integrated into a larger process learners tend to shift their attention towards what they perceive as the ultimate objective. Completing smaller tasks in the reflection process and slowly unravelling the narrative of the game could contribute to reaching the resolution of the entire story by proceeding in their reflection practice at a deeper level. and hence also understanding the importance of the task at hand.

Additionally, gamification makes good use of personalization by offering a narrative close to the user's personal reality that they can follow by accomplishing smaller tasks (Rinjeni et al., 2022). Morschheuser et al. (2014) experimented with students who were probed through a series of guiding questions to reflect on their behaviours, habits and thoughts. The interactive environment within which they were working offered a quantification of the learners' actions, supporting them to comprehend better the impact that their actions had on their progression. Even stronger, by utilizing adaptive storyline techniques the users can define their own learning path instead of following a standardized approach identical to all users, and thereby adjust the practical application of their learning to real life (Gerdenitsch et al., 2020), and carrier path (Ahmed & Asiksoy, 2021). Hence by utilizing a personally relatable narrative, the learners could bring the game's story closer to their own reality and comprehend how their behaviour, thoughts and actions in the gamified reflection can lead to different results in their reality outside of this activity.

In summary, incorporating game elements itto the reflection could simultaneously capture the learners' attention, enhance their motivation to participate, shift their focus on the process and establish a meaningful connection between in-game behaviour to the personal real-life goals of the learners. Given that those were precisely the elements that were previously identified as traditionally missing from the reflection (Chittooran, 2015), it can be assumed that the utilization of gamification might elevate the quality of reflection.

Current Study

Overall, it can be inferred that reflection is essential for developing self-directed learning skills. However, the students do not always welcome reflection, or they do not engage at high level with it. As a result, even when the students do engage with reflection, they reach very low quality of reflection. Gamification could be a possible solution both for

increasing the initial engagement with reflection and for increasing the quality of reflection that the students reach, due to the personalization and interaction that it offers.

To evaluate this notion, a study was conducted that utilized gamification elements on a reflection activity of university students. An experiment with two conditions, a gamified and a non-gamified reflection activity, was conducted. The reflection activity was offered to students on the subject of Research Methodology, as this appears to be one of the most challenging for social science students. The use of reflection could support the evaluation of their learnings through Research Methods, while the addition of gamification could support the students to become more engaged, personalize their reflection to the specific needs of their carreers as academics, and reach higher quality reflections. The research question that naturally emanates from those goals is:

To what extent do gamification elements improve the quality of reflection?

It was hypothesized that the utilization of gamification elements on the reflection activities would allow the learners to experience higher personalization and engagement levels, consequently leading to higher quality of reflection. Hence, the amount and quality of learning goals, the extent to which they reached those goals and the amount and quality of the consequent future learning goals for improvement were evaluated in this study. According to the literature, the learners in the gamified condition should reach higher quality of reflection in contrast to the ones in the non-gamified condition.

Methodology

Research Design

To investigate whether gamification could improve the quality of reflection a quasi-experimental study was conducted. The purpose of the study was to test the effect of the independent variable gamification on the dependent variable quality of reflection. To assess

the impact of the use of gamification on reflection two conditions were designed. In both conditions, the students followed identical reflection procedures, with the only difference being the existence of gamification. In the experimental condition, the students used a reflection with game elements, while in the control condition, they used the same reflection without gamification.

Participants

The experiment was conducted during tutorials of diverse courses of Research Methods offered by the University of Twente to pre-master, bachelor, and pre-bachelors (a.k.a. foundation year) students for the faculty of Behavioural Management and Social Sciences (BMS) department. In total 38 students between the ages between 20 and 36 (M_{age} = 22.82, SD = 0.47) participated in the experiment in both conditions. Their study majors were Business Administration (37%, N = 14), Communication Science (29%, N = 11), Psychology (24%, N = 9), Educational Science and Technology (5%, N = 2), Philosophy of Science and Technology (2.6%, N = 1) and Public Administration (2.6%, N = 1). Their nationalities varied between non-European (42%, N = 16), Dutch (39%, N = 15) and other European (19%, N = 7). The majority of the participants identified as female (68%, N = 26), whereas a smaller portion (31%, N = 12) reported to be male. For an overview of all the demographic characteristics see Appendix A. To investigate the differences between the two conditions, the participants were randomly assigned to either of the two conditions. The total group of 38 participants resulted in two groups. The first group consisted of 21 participants who followed the gamified version of reflection (experimental group) and the second of 18 followed the learning path without gamification (control group).

Instrumentation

Learning Material

Given that the tutorials were offered to students at different educational levels within higher education, the learning material differed substantially. The courses varied from introductory courses on Research Methods, to advance Statistics for Research and intense Research Methods rewind courses. At all levels the students seem to struggle the most with this subject (Buch-Hansen, 2022), and especially with finding a fruitful application of the subject to their future careers (Nind, 2020). Under the Pedagogical Content Knowledge (PCK) theory, the subject should not only be taught content-wise but also context-wise, so that knowledge is not only transferred as a generic mnemonic material but can also be understood under the student-specific contexts and be applied by each learner specifically (Sengul et al., 2020). Reflection and evaluation of the lifelong learning impact of that subject appeared to be a good fit for the purpose of understanding its impact on the students' future careers.

Intervention

During those lessons, the experiment of the current study was conducted taking the form of a reflection assignment, which the students had to fill in prior and posterior to the main learnings of each tutorial. The previously conducted literature review indicated that a single (Moroshkina et al., 2022), on-action (Uştuk & De Costa, 2020), evaluative (Cowan, 2006) reflection would be the most suitable for revising the students' learning strategy. Furthermore, to specifically assess the quality of reflection, the experiment was focused on the immediate content of reflection, and not on other sociocultural parameters that might have had a noteworthy influence on students' success (Nind et al.,2020).

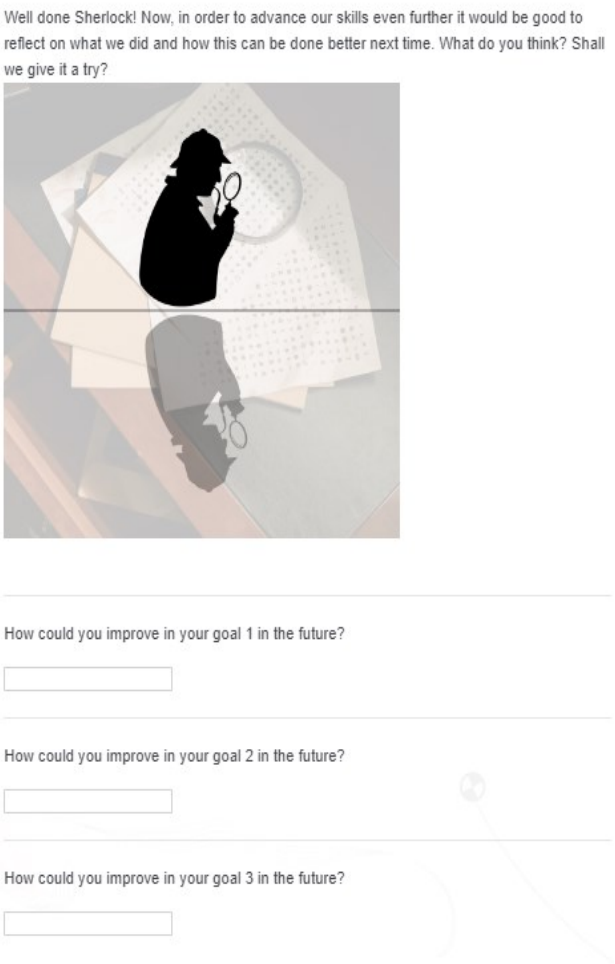
To collect the students' input a reflection form on the survey platform Qualtrics was designed for each condition. These forms served as a guide to support students navigate through the steps of the reflection by allowing them to set their learning goals prior to the tutorial and evaluate the level to which they reached them afterwards. The two conditions had

similar questions, but differed in the game elements that separated them into the two conditions. See Figure 1 for a short comparison, and Appendix B. and C. for a complete overview of the forms for the two conditions.

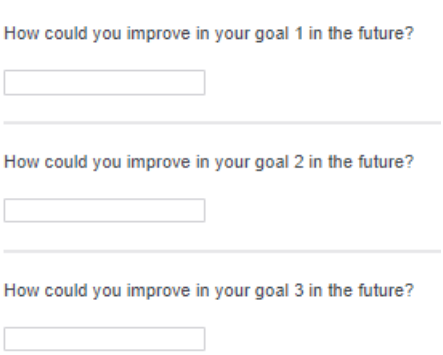
Figure 1

Open Ended Question for Experimental and Control Conditions

Experimental Condition



Control Condition



During both data-collecting moments, prior and posterior to the tutorial, open questions were provided to the students to allow them to personalize their reflection according to their own needs. Previous studies demonstrated that the utilization of open questions increases the learners' personalization, leading to higher sense of responsibility and efficacy in self-directed learning (Rinjeni et al., 2022). To prompt the students on the quality

of their learning goals, the S.M.A.R.T. criterion was utilized, which stands for *Specific*, *Measurable*, *Achievable*, *Relevant* and *Timely* (Bjerke & Renger, 2017). See Figure 1.

Figure 2

SMART Learning Goals Prompt

Measurements

To properly map the quality of reflection and the factors that contribute to it, two main categories of parameters were identified to be examined. The first category was related to the students' previous experience with the subject of the tutorial and with reflection as a learning method. For the study's purposes, those characteristics were termed *predisposition characteristics*. The second were the *main research characteristics*, that concerned outputs of the experiment regarding the quality of the learning goals.

Predisposition Characteristics.

The predisposition characteristics were evaluated due to literature indicating differentiations among the results of learners of the different conditions. More specifically, according to Wang et al. (2022) learners with little previous experience on a topic, appear to have less understanding of how this could be applied in the greatest picture of their future carrier. Similarly, when students appreciate the process of the reflection more, they have higher chances of conducting it properly with actual results for future applications (Hamilton

et al., 2019). Hence, the predisposition characteristics were operationalized on two grounds, the engagement and the interaction with both the subject and reflection. The measurement levels were scored on a five-level Likert scale, where five indicated the highest value and one lowest. Table 1 offers an overview of those parameters.

Table 1

Predisposition Characteristics and the Questions They Opted to Answer

Predisposition Characteristics	Question set to be answered
Enjoyment with RM	To what extent do the participant enjoy RM?
Ease with RM	To what extent do the participant find RM easy?
Frequency of use of reflection	How often did the participant use reflection?
Perceived usefulness of reflection	How useful did the participant find reflection?

Main Research Characteristics.

To measure the quality of the students' reflection, their reflection process was broken down into five parameters. *Learning goals setting* measured the raw scores of the learning goals that the students opted to reach during the tutorial. The operationalization therefrom occurred on the notion that more learning goals would indicate higher engagement (Viberg et al., 2020). With respect to the time restrictions, a maximum of three learning goals was allowed. Consequently, the identified goals were evaluated based on how they scored on the S.M.A.R.T. scale (Bjerke & Renger, 2017), with this parameter being named *SMART learning goals setting*. The number of criteria respected per learning goal indicated the quality of the goal opted to be reached. On this scale five stood for the highest possible score and zero for the lowest, where none of the S.M.A.R.T. criteria were met. To account for interrater reliability, the scores on this parameter were evaluated by two researchers, trained on scoring the data on the S.M.A.R.T. scale. The Cohen's Kappa test conducted showed low interrater reliability, $K = 0.35$ (Lange, 2011).

The amount of those originally set learning goals that were achieved was evaluated with the parameter *learning goals reached*. As previously with the first parameter of the main research characteristics, the raw data of this parameter were assessed on a scale from zero to three. Finally, the amount of learning goals opted to be reached in future tutorials, termed as *learning goals improvements*, was tested in the same manner as the parameter *learning goals setting*. Similarly, the quality of those newly set goals, termed *SMART learning goals improvements*, were measured in the same manner as the original *SMART learning goals setting*. For a quick overview of all the factors evaluated for the main research characteristics, see Table 2. For a complete view of all the questions and measurements see the reflection forms utilized in the Appendices. See Appendix A. for the control condition, and Appendix B. for the experimental condition.

Table 2

Main Research Characteristics and the Questions They Opted to Answer

Main Research Characteristics	Question set to be answered
Learning Goals Setting	How many goals did the participant set?
SMART L.G. Setting	How SMART were the learning goals set?
Learning Goals Reached	How many goals did the participant reach?
Learning Goals Improvements	How man improvements for reaching their Learning goal(s) did the participant set?
SMART L.G. Improvements	How SMART were the learning goals improvements?

Finally, to evaluate the reliability of the measurements a Cronbach's alpha reliability test was conducted. The main questions appeared to have high reliability (α = .88, CI = 0.8 - 0.92), which according to Taber (2017) is considered a good and reliable measure.

Procedures

Participation in the experiment was intertwined with following the two-hour-long Research Methods tutorials. Prior to their tutorials the researcher of the current study introduced the students to the experiment and invited them to participate voluntarily. The students that agreed to participate were appointed to condition A, experimental, or condition B, control, based on their position on the table. The students sitting on the right side of the table were sent to condition A, while the ones on the left were assigned to condition B. Based on the condition that they were appointed they could scan the relevant QR code or click on the related link to take part in the experiment. Both QR codes and links were shared with them through their learning environment, Canvas, where they usually follow their courses.

Opening the experiment environment, the students could get further information on the study and sign the informed consent. Consequently, some questions on their demographic characteristics were collected, such as age, study, gender and nationality. Then the students were requested to define their *predisposition characteristics* and then their *main research characteristics*. The first part of the latter was requested prior to the tutorial. There students of both conditions could set their learning goals, and the participants of the experimental condition could also set their progress bars. Once this part was completed, the tutorial lessons were offered by the teachers as they would normally proceed. The learning process that the students followed during the lessons was determined by the teacher during the tutorial.

After the tutorials were completed, the students could evaluate the extent to which they reached their learning goals as well as their quality and were asked to set new learning goals for future sessions. This levelled approach could allow the evaluation of the quality of the reflection. The experiment concluded with a debriefing explaining the differences between the two conditions and the actual goals of the study, namely the evaluation of the differences between gamified and non-gamified conditions. Finally, the withdrawal policy

and contact information to the researchers were restated, and the participants were thanked for their participation. No withdrawals were requested.

Analysis

To analyse the data, the statistical program R Studio, version 4.2.2. was utilized with among others the packages *Hmisc, ltm and rstatix.* Prior to the main analysis of the data, the parametric assumptions were tested. Most of the parametric assumptions were violated. The homogeneity of variance of the mean of the learning goals reached was tested with a Bartlett's test. The results showed that the homogeneity of variance was not violated, $K = 1.07$, $p = .302$. The additivity was tested with a scatter plot of all the main parameters against the dependent variable. The data appeared to have correct additivity, with a linear correlation, and multicollinearity, as the predictive parameters were strongly correlated with each other. See Table 3 for an overview. Furthermore, the normality was tested with histograms for the main parameters of the experiment. The histograms showed little normality, with some binomial and some skewed distributions. Similarly, the Wilcoxon test that was performed on the main data proved that the normality was violated, $V = 78$, $p = .017$. Since most of the parametric assumptions were violated, no parametric analyses could be conducted.

Table 3

Correlation Matrix of all Variables of the Main Research Characteristics

	Learning Goals Setting	SMART L.G. Setting	Learning Goals Reached	Learning Goals Improvements	SMART L.G. Improvements
Learning Goals Setting	1				
SMART L.G. Setting	.52 **	1			

Learning Goals Reached	.53 **	.38 **	1		
Learning Goals Improvements	.62 **	.72 **	.71 **	1	
SMART L.G. Improvements	.30	.40 **	.38 **	.72 **	1

Note: * $p < .05$ ** $p \leq .001$

Given the large number of contributing and intercorrelated variables of the main research characteristics to the common independent variable of the quality of reflection, the most suitable analysis was a multivariate analysis of variance (MANOVA) (Cohen, 2013). Two MANOVA analyses were conducted, one for the predisposition and one for the main research characteristics. Finally, the effect size was checked with a Cohen's F squared evaluation (Selya et al., 2012).

Results

Descriptive Statistics of Main Variables

An overview of the main descriptive statistics indicates that no large differences were present among the groups regarding their demographic characteristics. An overview of the data is provided in Table 4.

Table 4

Descriptive Statistics of Predisposition and Main Research Characteristics

	Gamified		Non-gamified	
	M	SD	M	SD
Predisposition characteristics				
Enjoyment with RM	3.33	1.15	2.78	1.17

Ease with RM	3.76	0.94	2.95	1.11
Frequency of use of reflection	2.71	1.31	2.73	1.32
Perceived Usefulness of use of reflection	2.57	1.16	2.73	1.45
Experimental findings				
Learning Goals Setting	1.14	1.35	1.22	1.40
SMART L.G. Setting	3.24	4.56	3.56	5.02
Learning Goals Reached	.91	2.41	2.45	3.07
Learning Goals Improvements	0.48	0.98	1.17	1.34
SMART L.G. Improvements	1.28	2.78	3	3.79

To evaluate whether there was a significant difference between the two conditions regarding their predisposition and main research characteristics two MANOVA analyses were conducted on all the variables of both categories towards the condition variable. The multivariate analysis of variance on the predisposition characteristics yielded no significant results, Pillai's Trace, $PT = .21$, $F(4, 34) = 2.29$, $p = .080$, with an equally small partial Eta Squared, $\eta^2 = .21$. Similarly, the MANOVA on the main research characteristics returned no significant results either, Pillai's Trace, $PT = .14$, $F(5, 33) = 1.08$, $p = .389$, $\eta^2 = .14$. In other words, no overall differences between the conditions were found. Comparing the means of all the factors of the two conditions, show some differences, especially between the values of learning goals reached, and the quantity and quality of improvement of the set goals. An overview of all the values can be found in Table 5.

Table 6

Multivariate Analysis of Variance of the Main Research Characteristics

	$F(1, 37)$	p	η^2
Predisposition Characteristics			

Enjoyment with RM	*2.23*	.144	.06
Ease with RM	*6.19*	.056	.14
Frequency of use of reflection	*0.00*	.985	>.001
Perceived Usefulness of use of reflection	*0.13*	.721	>.001
Main Research Characteristics			
Learning Goals Setting	.03	.858	.001
SMART L.G. Setting	.04	.827	.09
Learning Goals Reached	3.08	.085	.08
Learning Goals Improvements	2.65	.109	.001
SMART L.G. Improvements	3.44	.842	.07

Note: * $p < .05$ ** $p \leq .01$

Overall, the results of the experiment show little difference between gamified and non-gamified conditions.

Discussion

Overall, the findings of this study disaffirm the original hypothesis that the utilization of gamification could improve the quality of reflection of university students on the subject of Research Methodology. In contrast to the expectations and to findings from previous studies (Wang, 2022), this study demonstrated that students who took part in the experimental condition, using a reflection with game elements, demonstrated lower quality of reflection compared to the control condition, without gamification. The small advantages of the traditional over the gamified version of reflection were especially evident regarding the amount of learning goals reached, as well as the amount and quality of improvement points set.

Even though those results appeared to have no statistical significance, these findings could serve as an early indication that to reach learning goals and decide on improvement strategies for university students a gamified reflection poses no significant advantage. To reach a higher understanding of those findings, it appears necessary to take a closer look into the parameters that might have played a role in this conflict of results between the current and previous studies.

Perceived Usefulness of Reflection

The students' general poor scores in terms of reflection quality may be attributed to their overall low appreciation of reflection as a means of learning and development. To support this notion, a comparison of the predisposition characteristics between the two groups proves how moderately both of them rated reflection's usefulness. This corroborates with the findings from Chittooran (2015) suggesting low learning outcomes due to disconnection of the relevance of reflection to personal life. The study from Díaz-Iso et al. (2019) explored this notion empirically by evaluating students' appreciation of reflection on extracurricular activities. Their research showed low student engagement with activities offering additional labour without reward in exchange, such as grades or recognitions. Hence, a limitation of the current study might have similarly been the absence of an incentive in exchange for the students' participation. This consequently might have been a defining parameter in their lowered motivation to partake in or complete the reflection tasks with high rigorousness. Therefore, similar studies attempting to attract high levels of engagement with their participants, and professors aiming at involving their students with demanding tasks, such as longitudinal reflection, would be advised to make use of some reward system.

Likewise, the low scores on the SMART scale regarding both setting initial learning goals and defining improvements indicate lack of reflective skills. Students who possess a higher level of competence in evaluating their strengths and weaknesses can devise learning

strategies for personal and professional growth by tapping into their own knowledge, as well as sources in their environment, such as friends, grades and more (Chou et al., 2019). Expanding this concept, a study by Eshuis et al., (2022) illustrates the positive impact of guidance in enhancing reflection quality. The study compared various means, such as question probes, examples from experts and group discussions and compared those against the showcase of a singular example. The results indicate that the latter was insufficient for less proficient students on the subject under investigation. Applying these findings to the context of the current study, it could be suggested that the participants might have lacked the proficiency to establish their own learning goals. The current study missed identifying this as a possible implication, given the higher educational level of the students. Therefore, educators attempting to incorporate reflection in their instructions would be suggested to offer a priori training and consecutive guidance to the students regarding how to complete their reflection tasks in order to ensure higher quality outcomes.

Cognitive Load Balance

Furthermore, the gamified version of the reflection was significantly longer, with more text next to the visualisations and extra tasks, such as the progress bars. This might have led to a higher cognitive load for the learners, which could result in lower reflection quality (de-Marcos et al., 2014; Domínguez et al., 2013; Saab et al., 2007). Wu (2016) arrived at comparable results when the involved students attained higher cognitive load due to the complex design features of the mobile application utilized in their experiment. As in the case presented in the current study, the participants of the research of Wu (2016) had lower quality outcomes due to the increased cognitive load. This information cross-validates with the information from the field of user experience design, where it is underlined that game design should be simple and easily comprehensible to minimize cognitive load (Kalyuga & Singh, 2015; Large et al., 2004). The significance of clear instructions in facilitating student success

is underlined by Roksa et al. (2016) in a similar vein. It is possible that the instructions offered in the current study did not serve that purpose. Hence, clear, simple and concise instructions could reduce cognitive load and consequently enhance the activity outcomes.

Another approach to decrease cognitive load could be the adjustment of the reflection. As discovered by Uştuk & De Costa (2020) in their experiment about teacher reflection on their instructional practices, conducting the activity and simultaneously reflecting on it might be tight to emotional and cognitive overload. As the current study requested the students to set their learning goals prior to their tutorial and keep them in mind for subsequent reflection, it can be assumed that they were simultaneously engaged in two tasks, namely practising Research Methods and reflecting on their learning goals. This might have posed an important limitation to the experimental condition of the given study by increasing the cognitive load of the experimental condition with not only the learning and reflecting tasks but also a multitude of game elements. Therefore, it can be suggested that educators monitor and sustain a lowered cognitive load of their students by preserving simplicity in the reflective tasks they request.

Finally, the current study proposed the utilization of progress bars as a game element. However, given the nature of the platform used, those bars were not interactive. The students had to rather imagine adjusting their progression on those bars. Hence, another approach to decrease cognitive load could be the utilization of adaptive game elements. Zainuddin et al. (2020) attempted to improve engagement and lower students' cognitive load by utilizing electronic interactive platforms to perform quizzes, which were subsequently compared to paper-form versions. The interactive versions showed increased engagement and achievement among secondary school students. Similarly, a study from Steinrücke et al. (2023) demonstrated that adaptive approaches to learning might feel more personalized to the needs of the user and support the gamification elements better. Unfortunately, the present study did

not invest in a software or platform that would provide such advanced interaction and adaptability to the users' needs. The participants in the experimental condition were rather expected to set their own progress bars and report their progression. Clearly, employing such an interactive platform in reflection tasks could increase task engagement and shift the learners' attention from the reporting to the actual reflection and learning.

Conclusions

In conclusion, educators utilize reflection in response to the industry's demands for students with strong self-directed learning skills. However, students often undervalue reflection and do not engage with it. A solution that was incorporated in another setting to those ends, was gamification. Hence, the current study opted to evaluate the hypothesis that the utilization of game elements in the student's reflection would enhance reflection quality. Contrary to the original assumption, however, the use of game elements in this research proved to be less effective in offering high-quality reflection. From the results, it can be concluded that high-quality reflection requires students to first comprehend its importance in their life and be incentivised to engage with it. Similarly, educators need to ensure clarity and simplicity in the instructions to ensure a lower cognitive load. In short, gamification has the potential to enhance the quality of reflection, but the combination of the teaching methods of gamification and reflection should be well-balanced in order to succeed.

References

Ahmed, H. D., & Asiksoy, G. (2021). The Effects of Gamified Flipped Learning Method on Student's Innovation Skills, Self-Efficacy towards Virtual Physics Lab Course and Perceptions. *Sustainability*, *13*(18), 10163. https://doi.org/10.3390/su131810163

Andrade, H., & Brookhart, S. M. (2020). Classroom assessment as the co-regulation of learning. *Assessment in Education: Principles, Policy & Practice*, *27*(4), 350–372. https://doi.org/10.1080/0969594x.2019.1571992

Belim, V., Lyra, O., Teixeira, P., Caraban, A., Ferreira, M. E. C., Gouveia, R., Lucero, A., & Karapanos, E. (2014). *Beyond gamification*. https://doi.org/10.1145/2663806.2663828

Bjerke, M. B., & Renger, R. (2017). Being smart about writing SMART objectives. *Evaluation and Program Planning*, *61*, 125–127. https://doi.org/10.1016/j.evalprogplan.2016.12.009

Boud, D., & Garrick, J. (1999). *Understanding learning at work*. London: Routledge.

Buch-Hansen, H. (2022). Engaging social science students in the philosophy of science: 10 pieces of advice on how to teach a difficult subject. *Journal of Critical Realism*, *21*(4), 385–400. https://doi.org/10.1080/14767430.2022.2057064

Cavilla, D. (2017). The Effects of Student Reflection on Academic Performance and Motivation. *SAGE Open*, *7*(3), 215824401773379. https://doi.org/10.1177/2158244017733790

Chang, B. (2019). Reflection in Learning. *Online Learning*, *23*(1). https://doi.org/10.24059/olj.v23i1.1447

Chans, G. M., & Castro, M. P. (2021). Gamification as a Strategy to Increase Motivation and Engagement in Higher Education Chemistry Students. *Computers*, *10*(10), 132. https://doi.org/10.3390/computers10100132

Chernikova, O., Heitzmann, N., Stadler, M., Holzberger, D., Seidel, T., & Fischer, F. (2020). Simulation-Based Learning in Higher Education: A Meta-Analysis. *Review of Educational Research*, *90*(4), 499–541. https://doi.org/10.3102/0034654320933544

Chittooran, M. M. (2015). Reading and Writing for Critical Reflective Thinking. *New Directions for Teaching and Learning*, *2015*(143), 79–95. https://doi.org/10.1002/tl.20137

Chou, C., Shen, T., Shen, C., & Hsiao, H. (2019). A Investigate of Influence Factor for Tertiary Students' M-learning effectiveness: Adjust Industry 4.0 & 12-Year Curriculum of Basic Education. *International Journal of Psychology and Educational Studies*, *6*(2), 66–76. https://doi.org/10.17220/ijpes.2019.02.007

Cohen, J. (2013). Statistical Power Analysis for the Behavioral Sciences. In *Routledge eBooks*. https://doi.org/10.4324/9780203771587

Costa, C., & Aparicio, M. (2017). GAMIFICATION: SOFTWARE USAGE ECOLOGY. *Proceedings of the International Science and Technology Conference*. https://www.researchgate.net/publication/320730721_GAMIFICATION_SOFTWARE_USAGE_ECOLOGY#fullTextFileContent

Costa, C., Aparicio, M., Aparicio, S., & Aparicio, J. T. (2017). Gamification usage ecology. *Proceedings of the 35th ACM International Conference on the Design of Communication*. https://doi.org/10.1145/3121113.3121205

Cowan, J. (2006). *On becoming an innovative university teacher* (2nd ed.). Maidenhead: Open University Press.

Deterding, S., Dixon, D. A., Khaled, R., & Nacke, L. E. (2011). *From game design elements to gamefulness*. https://doi.org/10.1145/2181037.2181040

Díaz-Iso, A., Eizaguirre, A., & García-Olalla, A. (2019). Extracurricular Activities in Higher Education and the Promotion of Reflective Learning for Sustainability. *Sustainability*, *11*(17), 4521. https://doi.org/10.3390/su11174521

Esch, E. (1996). Promoting Learner Autonomy: Criteria for the Selection of Appropriate Methods. In R. Pemberton, E. S. Li, W. W. Or, & H. D. Pierson (Eds.), *Taking Control: Autonomy in Language Learning* (pp. 35–48). Hong Kong University Press.

Eshuis, E. H., Ter Vrugte, J., & De Jong, T. (2022). Supporting reflection to improve learning from self-generated concept maps. *Metacognition and Learning*, *17*(3), 691–713. https://doi.org/10.1007/s11409-022-09299-7

Fiorella, L. (2020). The Science of Habit and Its Implications for Student Learning and Well-being. *Educational Psychology Review*, *32*(3), 603–625. https://doi.org/10.1007/s10648-020-09525-1

Gerdenitsch, C., Sellitsch, D., Besser, M., Burger, S., Stegmann, C., Tscheligi, M., & Kriglstein, S. (2020). Work gamification: Effects on enjoyment, productivity and the role of leadership. *Electronic Commerce Research and Applications*, *43*, 100994. https://doi.org/10.1016/j.elerap.2020.100994

Hamari, J., Koivisto, J., & Sarsa, H. (2014). *Does Gamification Work? -- A Literature Review of Empirical Studies on Gamification*. https://doi.org/10.1109/hicss.2014.377

Hamilton, A., Rubin, D. B., Tarrant, M. A., & Gleason, M. (2019). Digital Storytelling as a Tool for Fostering Reflection. *Frontiers: The Interdisciplinary Journal of Study Abroad*, *31*(1), 59–73. https://doi.org/10.36366/frontiers.v31i1.443

Harrington, I., & Mellors, M. J. (2021). Utilising Online Gamification to Promote Student Success and Retention in Tertiary Settings. *International Journal of Higher Education*, *10*(7), 45. https://doi.org/10.5430/ijhe.v10n7p45

Hill, M., Peters, M. a. K., Salvaggio, M. R., Vinnedge, J., & Darden, A. (2020). Implementation and evaluation of a self-directed learning activity for first-year medical students. *Medical Education Online*, *25*(1). https://doi.org/10.1080/10872981.2020.1717780

Holder, N. a. K. A., Sim, Z. L., Foong, C. C., & Pallath, V. (2019). Developing a Reflection Guiding Tool for underperforming medical students: An action research project. *Tuning Journal for Higher Education*, *7*(1), 115–163. https://doi.org/10.18543/tjhe-7(1)-2019pp115-163

Hosseini, C., Humlung, O., Fagerstrøm, A., & Haddara, M. (2022). An experimental study on the effects of gamification on task performance. *Procedia Computer Science*, *196*, 999–1006. https://doi.org/10.1016/j.procs.2021.12.102

Hunicke, R., LeBlanc, M., & Zubek, R. (2004). MDA: A formal approach to game design and game research. *In Proceedings of the AAAI Workshop on Challenges in Game AI*, *4*(1), 1722–1727. https://game-developers.org/wp-content/uploads/2022/09/MDA.pdf

Kallevig, K. A. (2017). Perceptions of Failure in Education: Changing the Fear of Failure Through Gamification. *[Master's Thesis, Minnesota State University, Mankato]*. https://cornerstone.lib.mnsu.edu/etds/404/

Kalogiannakis, M., Papadakis, S., & Zourmpakis, A. (2021). Gamification in Science Education. A Systematic Review of the Literature. *Education Sciences*, *11*(1), 22. https://doi.org/10.3390/educsci11010022

Kalyuga, S., & Singh, A. (2015). Rethinking the Boundaries of Cognitive Load Theory in Complex Learning. *Educational Psychology Review*, *28*(4), 831–852. https://doi.org/10.1007/s10648-015-9352-0

Kaufmann, D. (2018). REFLECTION: BENEFITS OF GAMIFICATION IN ONLINE HIGHER EDUCATION. *Journal of Instructional Research*, *7*(1). https://doi.org/10.9743/jir.2018.12

Lange, R. T. (2011). *Inter-rater Reliability. In: Encyclopedia of Clinical Neuropsychology* (J. S. Kreutzer, J. DeLuca, & B. Caplan, Eds.). Springer. https://statisticsbyjim.com/hypothesis-testing/inter-rater-reliability/

Leijen, Ä., Pedaste, M., & Lepp, L. (2020). TEACHER AGENCY FOLLOWING THE ECOLOGICAL MODEL: HOW IT IS ACHIEVED AND HOW IT COULD BE STRENGTHENED BY DIFFERENT TYPES OF REFLECTION. *British Journal of Educational Studies*, *68*(3), 295–310. https://doi.org/10.1080/00071005.2019.1672855

Li, H., Majumdar, R., Chen, M. A., & Ogata, H. (2021). Goal-oriented active learning (GOAL) system to promote reading engagement, self-directed learning behavior, and motivation in extensive reading. *Computers & Education*, *171*, 104239. https://doi.org/10.1016/j.compedu.2021.104239

Lousberg, L., Rooij, R., Jansen, S., Van Dooren, E., Heintz, J., & Van Der Zaag, E. (2019). Reflection in design education. *International Journal of Technology and Design Education*, *30*(5), 885–897. https://doi.org/10.1007/s10798-019-09532-6

Marshall, T. F. (2019). The concept of reflection: a systematic review and thematic synthesis across professional contexts. *Reflective Practice*, *20*(3), 396–415. https://doi.org/10.1080/14623943.2019.1622520

Moroshkina, N., Savina, A., Ammalainen, A., Gershkovich, V., Zverev, I., & Lvova, O. (2022). How Difficult Was It? Metacognitive Judgments About Problems and Their Solutions After the Aha Moment. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.911904

Morschheuser, B., Rivera-Pelayo, V., Mazarakis, A., & Zacharias, V. (2014). Interaction and Reflection with Quantified Self and Gamification: an Experimental Study. *ResearchGate*. https://www.researchgate.net/publication/263444004_Interaction_and_Reflection_with_Quantified_Self_and_Gamification_an_Experimental_Study

Nah, F. F., Zeng, Q. L., Telaprolu, V. R., Ayyappa, A. P., & Eschenbrenner, B. (2014). Gamification of Education: A Review of Literature. In *Springer eBooks* (pp. 401–409). https://doi.org/10.1007/978-3-319-07293-7_39

Nind, M. (2020). A new application for the concept of pedagogical content knowledge: teaching advanced social science research methods. *Oxford Review of Education*, *46*(2), 185–201. https://doi.org/10.1080/03054985.2019.1644996

Nind, M., Holmes, M. D., Insenga, M., Lewthwaite, S., & Sutton, C. (2020). Student perspectives on learning research methods in the social sciences. *Teaching in Higher Education*, *25*(7), 797–811. https://doi.org/10.1080/13562517.2019.1592150

Okolie, U. C., Nwosu, H. E., & Mlanga, S. (2019). Graduate employability. *Higher Education, Skills and Work-based Learning*, *9*(4), 620–636. https://doi.org/10.1108/heswbl-09-2018-0089

Okoro, C. O. (2011, November 1). *Metacognitive Strategies: A Viable Tool for Self –Directed Learning*. https://www.richtmann.org/journal/index.php/jesr/article/view/11747

Polo-Peña, A. I., Frías-Jamilena, D. M., & Fernández-Ruano, M. L. (2020). Influence of gamification on perceived self-efficacy: gender and age moderator effect. *International Journal of Sports Marketing & Sponsorship*, *22*(3), 453–476. https://doi.org/10.1108/ijsms-02-2020-0020

Prasad, K., & Mangipudi, M. (2021). Gamification for Employee Engagement: An Empirical Study With E-Commerce Industry. *Montenegrin Journal of Economics*, *17*(2), 145–156. https://doi.org/10.14254/1800-5845/2021.17-2.12

R Core Team. (2022). *R: A language and environment for statistical computing* [Software]. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

Rinjeni, T. P., Rakhmawati, N. A., & Nadlifatin, R. (2022). A Systematic Literature Review on Personalized Adaptive Gamification. *2022 International Conference on Computer Engineering, Network, and Intelligent Multimedia (CE NIM)*. https://doi.org/10.1109/cenim56801.2022.10037386

Roksa, J., Trolian, T. L., Blaich, C., & Wise, K. (2016). Facilitating academic performance in college: understanding the role of clear and organized instruction. *Higher Education*, *74*(2), 283–300. https://doi.org/10.1007/s10734-016-0048-2

Saabye, H., Kristensen, T. K., & Wæhrens, B. V. (2022). Developing a learning-to-learn capability: insights on conditions for Industry 4.0 adoption. *International Journal of Operations & Production Management*, *42*(13), 25–53. https://doi.org/10.1108/ijopm-07-2021-0428

Seifert, T., & Gez, Y. (2021). Engaging Students Through Escape Games and a Play Environment During Recess. *International Journal of Game-Based Learning*, *11*(3), 1–18. https://doi.org/10.4018/ijgbl.2021070101

Selya, A. S., Rose, J. S., Dierker, L., Hedeker, D., & Mermelstein, R. J. (2012). A Practical Guide to Calculating Cohen's f2, a Measure of Local Effect Size, from PROC MIXED. *Frontiers in Psychology*, *3*. https://doi.org/10.3389/fpsyg.2012.00111

Sengul, O., Enderle, P., & Schwartz, R. S. (2020). Science teachers' use of argumentation instructional model: linking PCK of argumentation, epistemological beliefs, and

practice. *International Journal of Science Education*, *42*(7), 1068–1086. https://doi.org/10.1080/09500693.2020.1748250

Steinrücke, J., Veldkamp, B., & De Jong, T. (2023). The effect of self-reflection on information usage and information literacy in a digital serious game. *Computers and Education Open*, *4*, 100133. https://doi.org/10.1016/j.caeo.2023.100133

Toh, W., & Kirschner, D. (2020). Self-directed learning in video games, affordances and pedagogical implications for teaching and learning. *Computers & Education*, *154*, 103912. https://doi.org/10.1016/j.compedu.2020.103912

Uştuk, Z., & De Costa, P. I. (2020). Reflection as meta-action: Lesson study and EFL teacher professional development. *TESOL Journal*, *12*(1). https://doi.org/10.1002/tesj.531

Viberg, O., Khalil, M., & Baars, M. (2020). Self-regulated learning and learning analytics in online learning environments. *Proceedings of the Tenth International Conference on Learning Analytics &Amp; Knowledge*. https://doi.org/10.1145/3375462.3375483

Wang, Y. (2022). Can Gamification Assist Learning? A Study to Design and Explore the Uses of Educational Music Games for Adults and Young Learners. *Journal of Educational Computing Research*, *60*(8), 2015–2035. https://doi.org/10.1177/07356331221098148

Wirth, K. R., Nuhfer, E., Watson, R. E., Fleisher, S., & Bailey, R. (2021). Knowledge survey: Supporting students along pathways to self-direct learning with self-assessment. In A. G. Van Aarde (Ed.), *Self-Directed Learning: An imperative for education in a complex society - NWU self-directed learning series* (pp. 127–164). AOSIS Publishing. https://doi.org/10.4102/aosis.2021.bk279

Wisniewski, B., Zierer, K., & Hattie, J. (2020). The Power of Feedback Revisited: A Meta-Analysis of Educational Feedback Research. *Frontiers in Psychology*, *10*. https://doi.org/10.3389/fpsyg.2019.03087

Wohlfart, O., Adam, S., & Hovemann, G. (2021). Aligning competence-oriented qualifications in sport management higher education with industry requirements: An importance–performance analysis. *Industry and Higher Education*, *36*(2), 163–176. https://doi.org/10.1177/09504222211016284

Wolcott, M. P., & Lobczowski, N. G. (2021). Using cognitive interviews and think-aloud protocols to understand thought processes. *Currents in Pharmacy Teaching and Learning*, *13*(2), 181–188. https://doi.org/10.1016/j.cptl.2020.09.005

Wu, Y. (2016). Gamification design: A comparison of four m-learning courses. *Innovations in Education and Teaching International*, *55*(4), 470–478. https://doi.org/10.1080/14703297.2016.1250662

Yang, Y., Van Aalst, J., & Chan, C. K. K. (2019). Dynamics of Reflective Assessment and Knowledge Building for Academically Low-Achieving Students. *American Educational Research Journal*, *57*(3), 1241–1289. https://doi.org/10.3102/0002831219872444

Zainuddin, Z., Shujahat, M., Haruna, H., & Chu, S. K. W. (2020). The role of gamified e-quizzes on student learning and engagement: An interactive gamification solution for a formative assessment system. *Computers & Education*, *145*, 103729. https://doi.org/10.1016/j.compedu.2019.103729

Zimmerman, B. J. (2002). Becoming a Self-Regulated Learner: An Overview. *Theory Into Practice*, *41*(2), 64–70. https://doi.org/10.1207/s15430421tip4102_2

Appendices

Appendix A. – Demographic Characteristics of Participants

	Gamified		Ungamified	
	n	%	n	%
Gender	M = 1.71	SD =.46	M = 1.66	SD = .48
Female	15	71	12	66
Male	6	29	6	33
Study	M = 3.42	SD = 2.36	M = 2.11	SD = 1.53
Psychology	7	33	2	11
Business Administration	7	33	7	38
Communication Science	4	19	8	45
Public Administration	1	5	0	0
Educational Science & Technology	1	5	1	6
Philosophy of Science, Technology & Society	1	5	0	0
European Studies	0	0	0	0
Age	M = 23.81	SD = 4.74	M = 21.67	SD = 4.98
20	5	24	13	72
21	2	10	2	12
22	5	24	1	5
23	3	15	0	0
≥ 24	6	27	2	11
Nationality	M = 2.33	SD = 1.46	M = 2.94	SD = 1.21

Dutch	11	52	4	22
German	0	0	1	6
Other European	2	10	5	28
Other non-European	8	38	8	44

Appendix B. – Reflection Form Control Condition

https://utwentebs.eu.qualtrics.com/jfe/form/SV_eqyGCKzmLWtvOOa

UNIVERSITY OF TWENTE.

Introduction

Reflection on Research Methodology Course

Dear participant,
Thank you for taking part in this study!

Through this experiment it is attempted to investigate the impact that reflection has on the progress on students for the course of Research Methodology. This study is part of the thesis project of the student Olga Karageorgiou for the Bachelors of Psychology at the University of Twente.

Please read the information below about the details of our study.

Purpose
The purpose of this research is to understand better how using SMART learning goals at the beginning of a lecture could guide the learning process of a student and support them to redirect their learning towards those learning goals.

Procedure
Prior to the main experiment, a series of questions will be asked, regarding your demographic characteristics and your prior experience with the investigated topic. Consequently, you will be asked to formulate up to three learning goals for the tutorial and to check on their completeness by the end of the tutorial.
Your learning goals are personal and related to your own learning situation. Please create them carefully and answer the evaluation questions with honesty.

Please ***keep this page open*** until the end of the tutorial, so that you can fill in the reflection of your learning experience.

Confidentiality
All information obtained in connection with this study that can be identified with you will remain confidential. No individual identities will be used in reports or publications arising from the research. All data will be stored separately from names or other direct identifications of participants. Research information will be always kept in locked files. Anonymous raw data may be made available to other researchers for work quality evaluation purposes only (e.g. peer review, grading, etc.). Only the student researcher and the assessors thereof will have access to the files. Research material may be retained for up to 10 years before being deleted.

Risks or Discomforts
No risks with participating in this study are foreseen.

Participant Rights
Your participation is voluntary. You may choose not to take part in the study or to stop participating at any time, for any reason, without any consequences of any kind or loss of benefits to which you are otherwise entitled. To withdraw from participation later, please inform the principal investigator via email within 10 days of your participation. To those ends, you will need your identification number given that the study is completely anonymized to the researcher as well.

Identification of Investigators
If you have questions about your rights as a research participant, wish to obtain information about those, or to discuss any concerns about this study with someone other than the researcher and/or her supervisor, please contact the Secretary of the Ethics Committee, (ethicscommittee-bms@utwente.nl).
For further information about this study, contact the principal investigator/ tutor of the researcher Dr. Judith ter Vrugte (j.tervrugte@utwente.nl), or the student-researcher Olga Karageorgiou (o.karageorgiou@student.utwente.nl).

Active Informed Consent and Authorization Provisions

Consent indicates that:
- I agree to take part in the study.
- I understand that my participation is voluntary and that I am free to withdraw my participation, without explanation, until 10 days after participation.
- I understand that any information given by me may be used in future reports, articles, publications or presentations by the researcher/s, but that my data will not be identifiable.
- I understand that anonymized data will be kept according to university guidelines for up to 10 years after the end of the study.

I consent to participate in the study.

- ◯ Yes
- ◯ No

→

What is your (future) study?

- ○ Business Administration
- ○ Communication Science
- ○ Educational Science and Technology
- ○ European Studies
- ○ Philosophy of Science, Technology & Society
- ○ Psychology
- ○ Public Administration

What is your gender?

- ○ Male
- ○ Female
- ○ Gender Neutral
- ○ Transgender
- ○ Prefer not to disclose

What is your age?

Click to write Label 1 Click to write Label 2 Click to write Label 3

20 23 26 29 32 35 38 41 44 47 50

Years of age

What is your nationality?

- ○ Dutch
- ○ German
- ○ other European
- ○ other non-European

What is your previous experience with Research Methods & Descriptive Statistics?

	Very much	A lot	Neutral	A little	Not at all
Enjoyment	○	○	○	○	○
Ease	○	○	○	○	○

What is your previous experience with Reflection?

	Very much	Much	Neither-Nor	A little	Not at all
Frequency of use	○	○	○	○	○
Perceived Usefulness	○	○	○	○	○

→

Setting specific learning goals prior to learning or practising with learning material can support the learning process, and promote learning. To achieve better results, it is assumed that SMART goals can support the learners more than generic goals. In setting such goals, the following picture could be of support.

If that would be relevant for you, please write your goal(s) down on a paper.

Please set your Learning goals below. You may identify as many Learning Goals as you wish up to a maximum of 3.

If you do not have a learning goal, please indicate it by typing N/A.

Learning Goal 1

Learning Goal 2

Learning Goal 3

Did you reach your goal ?

- ○ No
- ○ Maybe
- ○ Yes
- ○ Not relevant to me

Did you reach your goal ?

- ○ No
- ○ Maybe
- ○ Yes
- ○ Not relevant to me

Did you reach your goal ?

- ○ No
- ○ Maybe
- ○ Yes
- ○ Not relevant to me

→

How could you improve in your goal 1 in the future?

How could you improve in your goal 2 in the future?

How could you improve in your goal 3 in the future?

→

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Debriefing

Dear participant,

Thank you again for participating in our study! The real purpose of this study was to investigate the use of gamification elements for the purposes of reflection. You were in the control condition, and hence did not have the gamified version. However, the questions you have received were the same as for the experimental condition, without the progress bars that the gamified version had. That means that you could utilize both versions for your learning evaluation in the future.

Withdrawing Policy

If you decide that you want to withdraw from this research, please contact us (researchers) within 10 days and quote your participation number to allow us to locate your data and withdraw it. Your participation number is: **151**

Other concerns

Furthermore, please contact the student-researcher Olga Karageorgiou (o.karageorgiou@student.utwente.nl), if you should have any (other) queries or concerns, or if you wish to know more about reflection and the outcomes of the current study.

If you feel unable to raise these concerns with us, then you may speak in confidence to the principal investigator/ tutor of the researcher Dr. Judith ter Vrugte (j.tervrugte@utwente.nl).

If you have questions about your rights as a research participant, wish to obtain information, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee, ethicscommittee-bms@utwente.nl.

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Appendix C. – Reflection Form Experimental Condition

https://utwentebs.eu.qualtrics.com/jfe/form/SV_0JVvw3dNwq20z1s

Introduction

Reflection on Research Methodology Course

Dear participant,
Thank you for taking part in this study!

Through this experiment it is attempted to investigate the impact that reflection has on the progress on students for the course of Research Methodology. This study is part of the thesis project of the student Olga Karageorgiou for the Bachelors of Psychology at the University of Twente.

Please read the information below about the details of our study.

Purpose
The purpose of this research is to understand better how using SMART learning goals at the beginning of a lecture could guide the learning process of a student and support them to redirect their learning towards those learning goals.

Procedure
Prior to the main experiment, a series of questions will be asked, regarding your demographic characteristics and your prior experience with the investigated topic. Consequently, you will be asked to formulate up to three learning goals for the tutorial and to check on their completeness by the end of the tutorial.
Your learning goals are personal and related to your own learning situation. Please create them carefully and answer the evaluation questions with honesty.

Please ***keep this page open*** until the end of the tutorial, so that you can fill in the reflection of your learning experience.

Confidentiality
All information obtained in connection with this study that can be identified with you will remain confidential. No individual identities will be used in reports or publications arising from the research. All data will be stored separately from names or other direct identifications of participants. Research information will be always kept in locked files. Anonymous raw data may be made available to other researchers for work quality evaluation purposes only (e.g. peer review, grading, etc.). Only the student researcher and the assessors thereof will have access to the files. Research material may be retained for up to 10 years before being deleted.

Risks or Discomforts
No risks with participating in this study are foreseen.

Participant Rights
Your participation is voluntary. You may choose not to take part in the study or to stop participating at any time, for any reason, without any consequences of any kind or loss of benefits to which you are otherwise entitled. To withdraw from participation later, please inform the principal investigator via email within 10 days of your participation. To those ends, you will need your identification number given that the study is completely anonymized to the researcher as well.

Identification of Investigators
If you have questions about your rights as a research participant, wish to obtain information about those, or to discuss any concerns about this study with someone other than the researcher and/or her supervisor, please contact the Secretary of the Ethics Committee, (ethicscommittee-bms@utwente.nl).
For further information about this study, contact the principal investigator/ tutor of the researcher Dr. Judith ter Vrugte (j.tervrugte@utwente.nl), or the student-researcher Olga Karageorgiou (o.karageorgiou@student.utwente.nl).

Active Informed Consent and Authorization Provisions

Consent indicates that:
- I agree to take part in the study.
- I understand that my participation is voluntary and that I am free to withdraw my participation, without explanation, until 10 days after participation.
- I understand that any information given by me may be used in future reports, articles, publications or presentations by the researcher/s, but that my data will not be identifiable.
- I understand that anonymized data will be kept according to university guidelines for up to 10 years after the end of the study.

I consent to participate in the study.

- ○ Yes
- ○ No

→

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What is your (future) study?

- ◯ Business Administration
- ◯ Communication Science
- ◯ Educational Science and Technology
- ◯ European Studies
- ◯ Philosophy of Science, Technology & Society
- ◯ Psychology
- ◯ Public Administration

What is your gender?

- ◯ Male
- ◯ Female
- ◯ Gender Neutral
- ◯ Transgender
- ◯ Prefer not to disclose

What is your age?

Click to write Label 1 Click to write Label 2 Click to write Label 3

20 23 26 29 32 35 38 41 44 47 50

Years of age

What is your nationality?

- ◯ Dutch
- ◯ German
- ◯ other European
- ◯ other non-European

What is your previous experience with Research Methods & Descriptive Statistics?

	Very much	A lot	Neutral	A little	Not at all
Enjoyment	○	○	○	○	○
Ease	○	○	○	○	○

What is your previous experience with Reflection?

	Very much	Much	Neither-Nor	A little	Not at all
Frequency of use	○	○	○	○	○
Perceived Usefulness	○	○	○	○	○

→

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Research Methodology is just like a detective work!

The researcher needs to collect data, devise a plan to approach solving the mystery of the research question and finally come up with a solution proving or disproving the original hypothesis of the suspect of the crime.

Case

Imagine that you are a detective then. You have multiple variables in the tutorial of today that could be the main parameter contributing to the relation you try to prove. But you need to discard the "fake" parameters that confound your data and remain only with the one "true" suspect parameter that actually conducted the crime... or maybe even define the "conspiracy" of parameters that lead to those uitcomes.

But you don't know how to conduct such an investigation. How could you learn more, in order to ensure that you can solve the crime in the most suitable manner? Maybe a visit at the library? Or some video tutorial? ... Or hey, this specific tutorial offered right now at this classroom could also help.

But you don't want to spend too much time in that! You need to solve the crime mystery and do it fast. So, let's set some specific learning goals that you can use in order to solve it. The following scheme can help you set up to 3 SMART learning goals.

But you don't want to spend too much time in that! You need to solve the crime mystery and do it fast. So, let's set some specific learning goals that you can use in order to solve it. The following scheme can help you set up to 3 SMART learning goals.

Learning Goal 1

Learning Goal 2

Learning Goal 3

→

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As a detective you want to monitor how you are progressing towards your goal. How will you keep track of this during tonight's' session? Think of a way for each goal.

No rush... But hey, time is ticking!
Maybe we could set some specific measures for when the learning objectives are reached? Or a timeframe to limit the time we spend on this task? Otherwise the suspect will fly away or commit another crime...

How would the progress bar of look like on a scale of 3?
Write 1 measument per line. e.g.
1 - Completed
2. - Partially completed
3 - Incomplete

How would the progress bar of look like on a scale of 3?
Write 1 measument per line. e.g.
1 - Completed
2. - Partially completed
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How would the progress bar of look like on a scale of 3?
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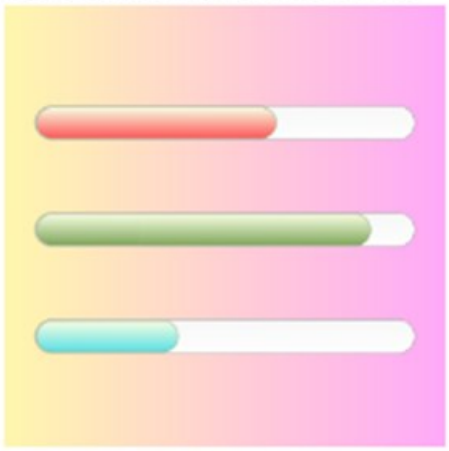
How would the progress bar of look like on a scale of 3?
Write 1 measument per line. e.g.
1 - Completed
2. - Partially completed
3 - Incomplete

→

Great Work detective!

Let's see how this went... Shall we?



Did you reach your goal ? On which level of your progress bar ?

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ Did not reach it at all
- ◯ Not relevant to me

Did you reach your goal ? On which level of your progress bar ?

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ Did not reach it at all
- ◯ Not relevant to me

Did you reach your goal ? On which level of your progress bar ?

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ Did not reach it at all
- ◯ Not relevant to me

Well done Sherlock! Now, in order to advance our skills even further it would be good to reflect on what we did and how this can be done better next time. What do you think? Shall we give it a try?

How could you improve in your goal 1 in the future?

How could you improve in your goal 2 in the future?

How could you improve in your goal 3 in the future?

→

Debriefing

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Appendix D. – Evaluation of the Quality of Learning Goals & Improvements for Experimental Condition

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	LG1		LG2		LG3		LG1_improve		LG2_improve		LG3_improve		
2	I want to finish unit 18 before the lecture ends.	4	I want to ask and understand the parts of the assignment I have questions about.	4	N.v.t.	0	Finish the unit before the class.	5	No improvement. I just needed to ask the question in class to understand what went wrong. For the future I should read my code more carefully since it was easily avoided mistake.	3	-	0	
3	During the lesson of today (RMDS) want to be able name the relation of the third	4		0		0	Use the theory as a backup when examining the relationship.	5		0		0	Specific
4		0		0		0		0		0		0	Measurable
5		0		0		0		0		0		0	Attainable
6		0		0		0		0		0		0	Realistic
7	Improve Teaching Quality	0	Reduce the number of assignments for completion	3	Improve Exam Review	0		0		0		0	Timely
8		0		0		0		0		0		0	
9		0		0		0		0		0		0	
10		0		0		0		0		0		0	
11	Find a balance in study/personal life	3	Achieving all the ECT's of the pre-masters	3	To use Rstudio to it's full potential	0		0		0		0	
12		0		0		0		0		0		0	
13	Understand the table more	2	Understand everything	0		0	Be more present	0		0		0	
14	Complete practice exam with a passing score by the end of the session	5	Understand the difference in third variable options by the end of the evening	4	Take 15 minute breaks every hour over the next 2 hours	4	By blocking out a time for each question	3	By reviewing practice problems for different statistical models	3	N/A - this was completed	0	
15	Familiar with different research methods	2	Consider ethical issues	0	Use appropriate research questions	2	Search some academic papers about it	2	Search some academic papers	2	Follow the SMART rule	4	
16	n/a	0	n/a	0	n/a	0	n/a	0	n/a	0	n/a	0	
17		0		0		0		0		0		0	
18		0		0		0		0		0		0	
19	Discover the fake parameters by the end of the seminar	3		0		0		0		0		0	
20		0		0		0		0		0		0	
21	I want to understand the full scope of descriptive statistics (which includes mean, mode, median and range) by the end	5	I want to understand the full scope of a difference between a type 01 and a type 2 error by the end of the week	4	I want to understand homoscedasticity understood well by the end of the seminar	4		0		0		0	
22	I want to improve my statistical skills by studying more of math in Jarco's class and improve by the end of term 3	4	I want to improve my analysis of hypothesis and interpretation skills by studying and doing assignments by the end of term 3	5	I want to improve my critical thinking skills because it would be useful for research method and for my exams in week 11 and that can be done	3		0		0		0	

Appendix E. – Evaluation of the Quality of Learning Goals & Improvements for Control Condition

LG1 Learning Goal 1		LG2 Learning Goal 2		LG3 Learning Goal 3		LG1_improve How could you improve in your goal 1 [QID11-ChoiceTextEntryValue] in the		LG2_improve How could you improve in your goal 2 [QID13-ChoiceTextEntryValue] in the		LG3_improve How could you improve in your goal 3 [QID14-ChoiceTextEntryValue] in the		
	0		0		0		0		0		0	
Get 2 chapters done before the end of the study hours	4	Finalize the assignments before the deadline	5	Ask question during the study hours	5	Bring head sets to focus more	3	Be sure of when the deadline is	2		0	
	0		0		0		0		0		0	
N/A	0	N/A	0	N/A	0	having a goal	4	having a goal	4	having a goal	4	Specific
To understand what sampling is (min definition).	4	To understand how i can apply sampling to the real world.	3	To understand what are the complications by using sampling and how to best avoid them.	4	look at alternate definitions	4	by trying to apply it to the real world		by trail and error of getting different samples and by looking up common complications that come up regarding		Measurable
Fine the difference between quantative method or quantitative method	2	Choose correct samples	2	Familiar with methodology	2	Find academic information	3	Find academic information	3	Find academic information	3	Attainable
Cooperate in an interdisciplinary team in order to tackle a globally challenging problem and develop a mitigation strategy for it within one semester.	5	Be able to convey knowledge about algorithms and data-structures by designing curriculum, assingments and conducting classes	4	Deepen my knowledge in project managment by taking courses related to that topic and completing the assingments in the second quartile of the	5	by planning out the activities	2	more realistic class planning	2		0	Realistic
N/A	0	N/A	0	N/A	0		0				0	Timely
Timely	0	Relevant	0	Specific	0	No problem	0	Focus on things I will ended use in the future.	2	With the help of my teachers, do a study on what are the specifics	3	
estudy week 3 by reading the lesson material and watching videos on youtube. Its super relevant because I'll need it for project and the test. I will study on week	5	d	0		0	studying as planned on week 5	3		0		0	
	0		0		0		0		0		0	
	0		0		0		0		0		0	
	0		0		0		0		0		0	
	0		0		0		0		0		0	
How can I succesfully learn why it is important to understand research methodology?	3		0		0	To more focus on the underlying meaning instead of focusing on how to do things.	3	-	0	-	0	
N/A	0		0		0		0		0		0	
Time my researcher skills better	3	Understand the math problems during this course	3	Develop quicker analysis skills (Research methods)	2	More organisation, proper identification of the problem.	2	More practice, being more attentive at lectures and seminars and strengthening my knowledge afterwards	3	Study some of the process by hard (understand them fully), have a plan of action for a plain research	4	
	0		0		0		0		0		0	
	0		0		0		0		0		0	
	0		0		0		0		0		0	
	0	Understand the different standard deviation according to the population		Understand and distinguish the difference between Type I and Type II	3		0		0		0	