Fabula rasa

by Davide Zanon

Gamifying a storytelling platform to enhance proactive science communication from TU Delft researchers

MSc Science Communication graduation project 2020
Mentored by Drs Éva Kalmár, Dr Rens Kortmann, Dr Maarten van der Sanden

This research project is dedicated to whoever can change the world, but chooses not to.

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Chapter 1

Introduction

Chapter 1 introduces the current state of the art of Science Communication, scientific storytelling and the use of online storytelling platforms within the TU Delft, to introduce the problem statement and the research question, and sub-research questions of this research project. The focus of this graduation project consists in lowering the barriers that TU Delft researchers encounter when submitting story ideas to engage in proactive co-creation of storytelling. The method section discusses the scientific process, from the initial literature review until the evaluation of the first iteration of the design, followed during this research project.

Despite the scientific community has focused much attention on improving communications between scientists and the public (Iyengar & Massey, 2018), and most scientists, universities and science organisations consider visibility in the media relevant (Peters, 2013), scientists may still find barriers when engaging in public communication of science. Reason being that scientists may perceive science communication as outside of their role and a potential risk to their reputation due to potential peer-based informal sanctions (Johnson et al., 2013). Also, scientists may be uninclined to interact with the public as audiences are more willing to accept normative evaluations, namely what is "good" or "bad", from narratives than from more logical-scientific arguments (Dahlstrom, 2014, and citations in there). Science communicators enter the picture by playing a valuable role as facilitators of information flow to journalists and support for scientists (McKinnon et al., 2017), while focusing their agenda on connecting science with the rest of society, and protecting scientists and scientific institutions (McKinnon et al., 2019, and citations in there).

To connect science with the public, Joubert et al. (2019) mention in their study that science communicators must make science-related information engaging and relevant; making the target audience care and creating an emotional connection between the scientists and the target audience, e.g. the public. To help the public make sense of science and care about science-related issues, science communicators have renewed their attention on the potential of storytelling as a tool when communicating about science (Joubert et al., 2019). The emphasis on narrative not only reflects the ability of stories to help achieve objectives related to human interest and learning; storytelling also allows presenting compelling characters who overcome struggles to achieve pro-social gains (Besley et al., 2019). The literature within the study of Cormick (2019) mentions that framing information in stories is an excellent method to (i) increase people's likelihood to remember information, (ii) reduce counter-arguing, (iii) make people feel the experience being described as their own, (iv) be much more convincing than just data, and (v) increase engagement when communicating science to non-expert audiences.

TU Delft encourages TU Delft researchers to engage in scientific storytelling for wide audiences through external and, especially, internal news outlets. In this scenario, the task of science communicators is counselling TU Delft researchers to target the most appropriate news outlet and training them to frame communication and control its outcome and convey scientifically accurate information. At the beginning of 2020, a new TU Delft-owned non-profit storytelling platform for internal and

external communication for all TU Delft faculties will go live and share stories appealable for TU Delft researchers, students, employees and larger audiences in general. The main idea of the storytelling platform is to foster collaboration and innovation within the TU Delft since researchers happen to work on their projects, potentially unaware of what happens within their department, faculty or the TU Delft campus. The editorial team's task is to write the story, while TU Delft researchers provide information to the editors through interviews, feedback on the drafts and have the last opinion in regards to its publication. One of the current challenges of the TU Delft editorial team of science communicators led by Roy Meijer, director of the storytelling platform, is searching for stories aligned with the platform's communication strategy. This operation can be time-demanding given that science communicators are, most of the times, initiating contact with TU Delft researchers and convince TU Delft researchers of the usefulness of engaging in scientific storytelling. Reason being that dissemination of scientific research is acceptable when scientists do not have proactive media contact, and it is the principal investigator that tends to interact with the media within a research group (Peters, 2013, and citations in there). This barrier may discourage researchers who have a desire to engage in storytelling proactively but lack the scientific status to do so or are unaware of the inbound consequences of proactively communicating science to the public within the TU Delft. The following subchapter will illustrate the problem statement.

Problem statement

As found in the above sections, **TU Delft researchers have limited measurable data of the inbound effects of proactively engaging in co-creation of scientific storytelling for wide audiences.** Persuading TU Delft researchers to understand the benefits of initiating contact to engage in co-creation of storytelling by pitching story ideas, and the inbound and outbound benefits of storytelling, can be beneficial for them, and Meijer and his team. The results emerging from this report in regards to the above issue can be interesting for the Science Communication department research agenda and further expand existing theories on enhancing collaboration within universities and scientific organisations. The next subchapter will focus on explaining the research question and sub-research questions of this graduation project.

Research question

To motivate TU Delft researchers into proactively contacting the editorial team to pitch story ideas and engaging in co-creation of scientific storytelling for wide audiences, using gamification can be an effective mean as its central idea is to transfer the motivational potential of games to non-game environments, creating activities that evoke game-like experiences (Groening and Binnewies, 2019). Several studies in the past decades have cited the persuasive strategies within the study of Fogg (2002) to motivate users specific behaviours within gamified designs, and some examples of gamification used to promote co-creation of storytelling are *MoVie* (Multisilta & Niemi, 2014), a research platform that promotes a cooperative creation of mobile video stories in learning and education, and *#iziTRAVELSicilia* (Giaccone & Bonacini, 2019), a web-based platform to promote Sicilian cultural heritage and tourist attractions through content co-creation with local inhabitants.

The above premises are helpful to identify the research question of this graduation project in **how can gamification be used to proactively engage TU Delft researchers in online scientific storytelling by pitching story ideas to the editorial team of a TU Delft-based storytelling platform for wide audiences?** These three sub-research questions follow to help to answer the research question:

1. Which factors impact TU Delft researchers' willingness to engage in public communication of science through online scientific storytelling?
2. What guidelines can be drawn from the identified factors, design literature and gamification literature to guide the gamified design to improve TU Delft researchers' willingness to engage in online scientific storytelling through the TU Delft-based storytelling platform?
3. How can the proposed hypothetical design effectively engage TU Delft researchers into proactive submission of story ideas according to experts?

The following subchapter is going to elaborate on the research method used within this graduation project.

Methods

The research method focused on a design-based approach to develop solutions for the research question and testing how well such solutions work. The next iterations may then be adapted and re-tested through iterative experiential prototyping until the total prototyped socio-technical system affords the targeted motivational experiences (Deterding, 2014). By using this approach, the research project started from a literature review, proceeded by deriving the design guidelines and translating them

into a first iteration of the gamified design for the storytelling platform, and concluded with an evaluation from experts. The following sections will elaborate on the methods used to reply to the three sub-research questions in detail.

Predictors of engagement

The study started with a literature review to determine TU Delft researchers' predictors of engagement in public communication of science within existing peer-reviewed journals in the field of Science Communication, Social Science and Psychology using Scopus, the online abstracts and citation database from Elsevier. The used keywords were *narrativ**, *"science communication"*, *"science journalis*"*, *"public engage*"*, *"response eff*"* in different orders or combinations. The literature review narrowed down the most consistent and substantive predictors of engagement in a list to use in the following part. The next part of the study focused on evaluating TU Delft researchers' willingness to engage in scientific storytelling through "Stories of Science", a storytelling web-platform used within the TU Delft Civil Engineering and Geosciences (CE&G) faculty similar to the new storytelling platform in development. The study used the Technology Acceptance Model (TAM) (Davis, 1989) to analyse a sample of CE&G researchers' attitudes towards the platform through a Likert-type scale questionnaire (Likert, 1932). The used questionnaire was non-validated and implemented questions from similar questionnaires, and the predictors of engagement found during the literature review. The results of such analysis answered the first sub-research question by determining the factors that impact TU Delft researchers' willingness to engage in public communication of science.

Design guidelines

In this part, the study started with a literature review within gamification by consulting peer-reviewed journals in the field of Business and Computer Science to determine the gamification elements can translate the findings from Chapter 2, and use gamification frameworks to analyse effective gamification case studies in contexts similar to the co-creation of storytelling between TU Delft researchers. The used keywords were *gamific**, *"intrinsic mot*"*, *"public engage*"*, *"response eff*"* and *"gamification frame*"* in different orders or combinations. The study of Mora et al. (2017) performs a systematic filtering process to narrow down the available gamification frameworks, and a comparative analysis of these framework shows the Octalysis to be one of the three with the highest total score and important scores in all the analysed categories, and usable for any desired purpose. It is the only one among the top three scoring frameworks to allow analysing the effectiveness of existing gamified designs in motivating their users. Chou (2015) defines the Octalysis Framework as a human-centric gamification

design framework that lays out the eight core drives for humans motivation. Reinforcing the core drives related to the right hemisphere of the brain (Empowerment, Social Influence and Unpredictability), positively affect users' intrinsic motivation — performing an activity simply because it is interesting, brings enjoyment and is satisfying (Miller et al., 1988). Reinforcing Scarcity, Unpredictability and Avoidance, affects the left hemisphere and, consequently, extrinsic motivation — performing an activity because it leads to an external outcome (Miller et al., 1988). White Hat core drives (Accomplishment, Epic Meaning and Empowerment) are motivation elements that make users feel powerful, fulfilled, and satisfied. Black Hat core drives (Scarcity, Avoidance and Unpredictability), make instead users feel obsessed, anxious and addicted. Solely acting on White Hat core drives may fail to involve less motivated players and create a sense of urgency, and basing the design exclusively on intrinsic motivation may create barriers for new users. The Octalysis framework analysed (i) the current effectiveness of Stories of Science to motivate TU Delft researchers to co-create storytelling for wide audiences with the editorial team, (ii) a case study of balanced and effective gamification in a similar scenario, and (iii) the conceptual design. Figure 1 displays the core drives of the Octalysis framework.

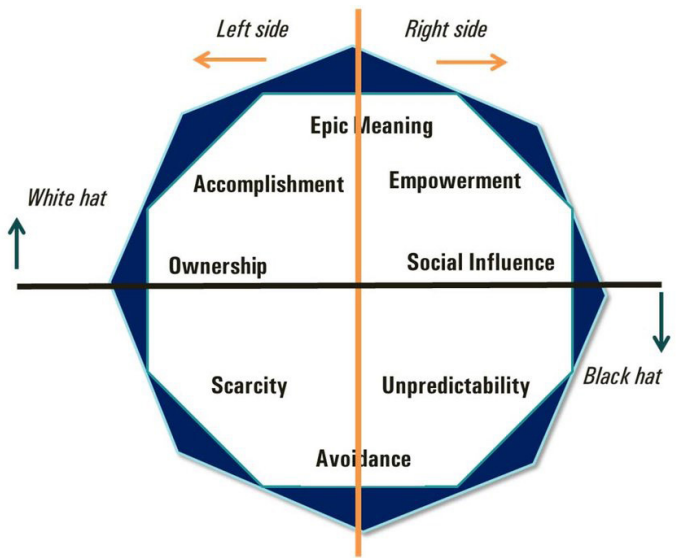


Figure 1 - *A view of the Octalysis framework (Chou, 2015).*

From the second literature review, the study chose a morphological to generate a scenario for the conceptual design. The morphological chart provides a structured approach to concept generation by capturing the necessary functionalities intended for design and exploring alternative means and combinations for a defined design problem (Cross, 1989). The study used the morphological chart to select which gamification elements to include from the gamification literature review, the

analyses performed with the Octalysis framework, logic and personal preference. The Octalysis confirmed that the chosen scenario balances the experience for its users, and the resulting lists of guidelines answers the second sub-research question. Such guidelines are implemented in the following part of the study.

Design phase & Evaluation

The other gamification framework chosen from the study of Mora et al. (2017) is the Six D's Gamification framework developed by Werbach and Hunter (2015). This framework has the highest score in the study and is suitable for any product since it uses game elements and game-design techniques in non-game contexts. Werbach and Hunter (2015) adopt the Hedonic motivation system adoption model (HMSAM) (Lowry et al., 2013) to evaluate the users' response towards the gamified design. Lowry et al. (2013) developed the HMSAM based on the Technology Acceptance Model (TAM), and it includes constructs that expend the effects of intrinsic motivations within traditional technology acceptance factors, as shown in Figure 2.

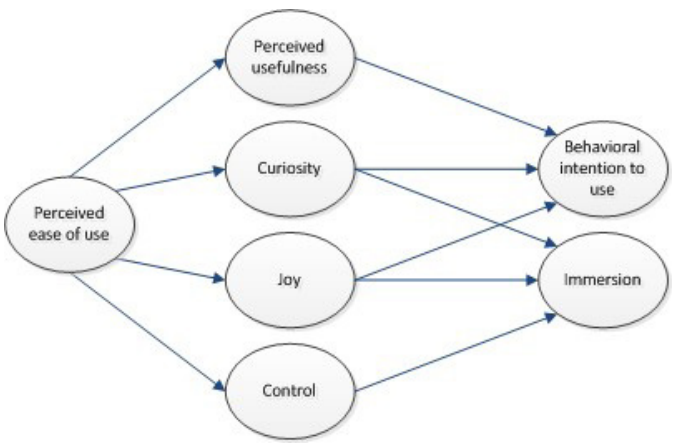


Figure 2 - *The Hedonic motivation system adoption model (Lowry et al., 2013).*

Upon completing the first iteration of the hypothetical design, the case owner and a gamification expert evaluated it. These two subjects were selected since the case owner has a great deal to share on the incoming platform and co-creating communication with TU Delft researchers for the public, while the gamification expert can provide valuable feedback on the gamified design itself. The subjects took part in two separate semi-structured interviews to freely elaborate on which gamification elements seem effective in motivating TU Delft researchers towards proactive story ideas submission, and which instead need improvements. The outcome of their evaluations and the additional inputs for the next phases of the project answered the third and final sub-research question. Figure 3 illustrates a schematic representation of the research methods for this graduation project.

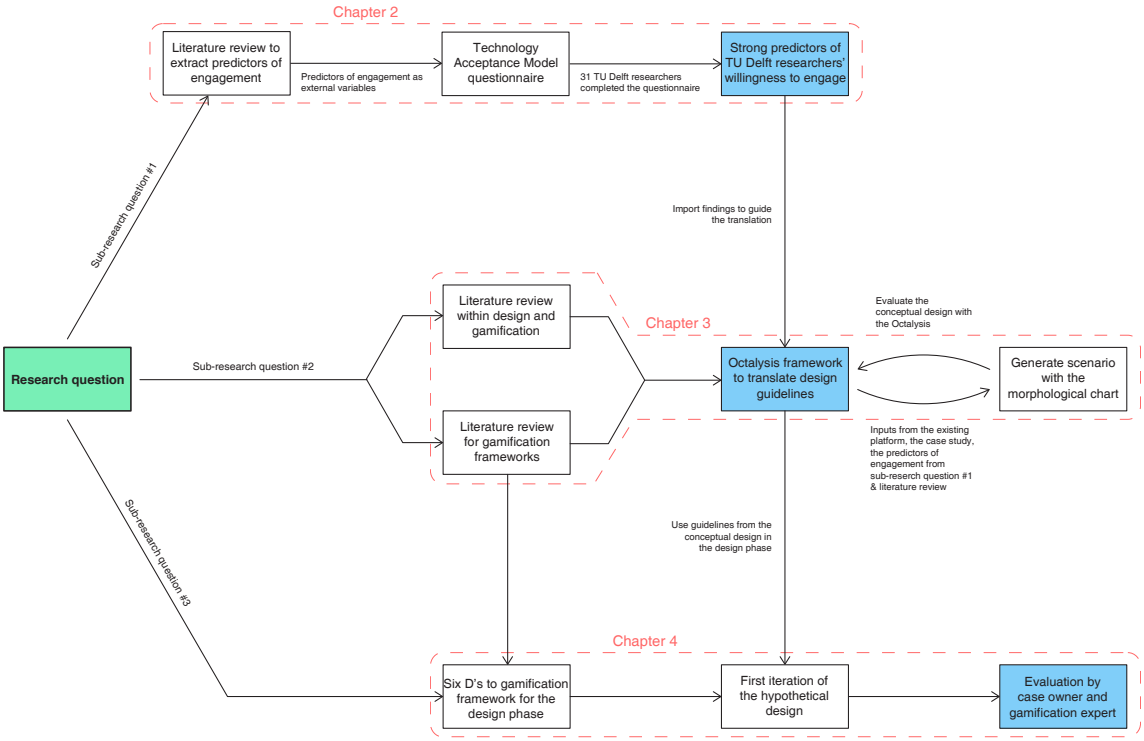


Figure 3 - *Scheme of the research methods by the author*

The remaining chapters focused on discussing the findings of this research project and proposing future developments. Chapter 2 will investigate the first sub-research question and determine the factors that impact TU Delft researchers' willingness to engage in public communication of science through online scientific storytelling.

Chapter 2

Predictors of engagement

Chapter 2 begins by introducing the main difference in language between scientists and journalists, the main actors who ultimately structure mass media communication, and of how scientists may perceive the use of narrative information. The literature review identified some drivers that can predict scientists' willingness to engage in public communication of science: Demographics, Attitude toward Engagement, Perceived Norms, Self- and Respondent efficacy, Perceived Enjoyment. The study translated such drivers into external variables for the Technology Acceptance Model (Davis, 1989) to assess a sample of 31 TU Delft researchers' attitude towards "Stories of Science", a storytelling platform similar to the one in development. The results proved that Response Efficacy is the highest-scoring variable, and can be a strong predictor of Perceived Ease of Use and Perceived Usefulness of Stories of Science. Also, Response Efficacy proved to be mainly a strong predictor for current users and younger, untrained in communication or unfeatured TU Delft researchers. Intrinsic motivation scored consistently higher than extrinsic motivation and should be prioritized to motivate researchers in the following chapters. Response Efficacy is the chosen predictor to turn into gamification elements in the following chapters.

This chapter aims at answering the first sub-research question: *which factors impact TU Delft researchers' willingness to engage in public communication of science through online scientific storytelling?* In the context of storytelling, Dahlstrom (2014) mentions in his study that integrating narratives, single stories related to each other (Cormick, 2019, and citations in there), with science is a relatively recent phenomenon. While media practitioners, such as science communicators, have to rely on stories, anecdotes, and other narrative formats to catch attention, cut through the information clutter and resonate with their audiences (Dalhstrom, 2014), science does not hold any intrinsic advantage in creating captivating stories for mass audiences (Dahlstrom & Scheufele, 2018). Scientists and journalists, the media practitioners ultimately structuring communication in the public arena, can be like strangers to each other; unable to understand each other's language and driven by different agendas (Peters, 2013). In regards to languages, the literature within Dahlstrom (2014) mentions that narratives contrast with the logical-scientific communication underlying most of the sciences. The three main areas where logical-scientific and narrative formats differ are in the direction of generalizability, reliance on context, and standards for legitimacy, as shown in Table 1.

	Narrative information	**Logical-scientific information**
Generalizability	Inductive reasoning	Deductive reasoning
Reliance on context	Context-dependent	Context-free
Standards for legitimacy	Verisimilitude of the situation	Accuracy of its claims

Table 1 - *Language differences between journalists and scientists (Dahlstrom, 2014, and citations in there)*

These differences create a murky arena for storytelling, making scientists lack communication skills to relay information to the public (Besley & Tanner, 2011), worry that their colleagues may look down on those who take part in public communication (Martinez-Condo, 2016), or potentially perceive stories as manipulative or as oversimplifications (Dahlstrom & Scheufele, 2018). Although these factors cast a negative light on engagement in co-creation of storytelling for wide audiences, Besley et al. (2018) describe Science Communication as a planned behaviour that might be changed through efforts to affect available drivers of that behaviour. Besley et al. (2018) identify these predictors for specific behaviours related to willingness to engage as *Demographics*, *Attitude Toward Engagement and Audience*, *Perceived Norms*, *Self- and Respondent Efficacy*. Another variable worth considering in this project is Perceived

enjoyment as Besley et al. (2018) do not identify it as a predictor in their study, but identify the relevance of the expected quality of the experience, i.e. enjoyable and pleasant, in the scientists' Attitude toward Engagement. Besides, when discussing what influences the usage of Information Technology (IT) such as online storytelling platforms, Davis et al. (1992) describe perceived enjoyment as intrinsic motivation. Since Entradas et al. (2019), e.g. in climate change, show that it is primarily intrinsic motivation, as opposed to extrinsic rewards, which drives scientists to engage in public communication of science, it is worth considering both *intrinsic* and *extrinsic motivation* as predictors of engagement for engagement in online scientific storytelling. The following subchapters will analyse each variable in detail.

Literature review

Besley et al. (2018) identify age, sex and scientific status as possible drivers for engagement within the Demographics driver. In general, the study mentions that scientists in the middle age-groups are more likely to be willing to engage when compared with the youngest and the oldest age-groups. However, the study also mentions that relatively younger scientists are more willing to engage in online media, such as storytelling platforms, compared to older and mid-career scientists, who are more favourable to engage through traditional news media. In regards to scientific status, Entradas et al. (2019) mention that are the most published scientists to be more likely to engage with the public rather than the oldest, regardless of mode. Besley et al. (2018) mention that communication training increases scientists' willingness to engage. The literature within Besely et al. (2018) shows both descriptive evidence of differences between fields for the amount of media contacts and, at the same time, limited evidence that academic area is a primary driver of engagement behaviour. Also, Besley et al. (2018) comment that women and men do not seem to be different in their willingness to engage face-to-face and online.

Attitude Toward Engagement

The literature within Besley et al. (2018) suggests that positive attitude toward the engagement experience appears to be a consistent predictor of willingness to engage and that scientists who have a relatively more positive attitude toward engagement will be more willing to engage. Besley et al. (2018) further discuss through their results that the expected quality of the experience, e.g. enjoyable and pleasant, was a more consistent and substantive predictor than what scientists think about their likely audiences' treatment toward them. The literature within the same study further suggests that viewing negatively the public seems unlikely to affect scientists' communication willingness.

Perceived Norms

Perceived Norms refers to "the person's perception that most people who are important to him think he should or should not perform the behaviour in question" (Venkatesh et al., 2003). Any person, e.g. a communication trainer, or scientific organization that wants scientists to use, or not use, a communication tactic might expect to especially benefit from assessing whether their scientists view that tactic as ethically acceptable and acceptable to their peers (Besley et al., 2019). The literature within Besley et al. (2018) mentions that scientists who perceive that their colleagues are engaging in public communication of science will be more willing to engage themselves and that scientists who perceive that their colleagues would have positive normative beliefs about those who engage are more likely to engage. Nevertheless, the results of the same study show that scientists' perceptions about their colleagues' behaviour and attitudes toward engaged scientists are not substantive statistical drivers of willingness to engage. The literature within Besley et al. (2018) further mentions that scientists value a certain amount of engagement from colleagues, but would question any engagement that took time away from relevant research or engagement that was done inappropriately as more important predictors.

Self- and Respondent Efficacy

Self-Efficacy refers to an individual's judgment of his or her own capability to perform a specific task (Bandura, 1982). Besley et al. (2018) mention within their study that scientists who perceive that they can engage skillfully and not to experience difficulties in explaining their subject to the public are more likely to engage, regardless of mode. However, the results of the same study discuss that Self-Efficacy seems to be a significant predictor in face-to-face engagement, but not in other forms of engagement. When analysing time pressure as potential barriers, Besley et al. (2018) further explain that showing scientists that engagement can make a difference and that helping scientists on time-consuming tasks (e.g., logistics, presentation, design, and evaluation) can increase willingness to engage.

Response-Efficacy concerns the individual's belief that a specific action will be useful; for example, if the scientists' efforts in communication are likely to make a difference (Besley et al., 2018). While previous studies, e.g. Dudo and Besley (2016), mentioned the importance of "knowing your audience" for what types of impacts scientists are hoping or expecting to have on those with whom they are communicating and the logic of how they think those impacts are most likely to occur, Besley et al. (2018) mention that knowing the audience does not seem to be a relevant predictor of engagement. Besley et al. (2018) further discuss that finding ways to track engagement impacts, and showing scientists that engagement can make a difference,

can boost scientists' willingness to engage. Moreover, while Besley et al. (2018) mention in their study that both quality and impact of the communication are important, some scientists may prefer producing higher volumes of communication with lower quality communication, e.g. using Twitter, over carefully crafted communication, e.g. writing in editorial magazines.

Perceived Enjoyment

As briefly mentioned in the above paragraphs, Davis et al. (1992) described perceived enjoyment as "the extent to which the activity of using the computer is perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated." When distinguishing between internal and external motivations, Miller et al. (1988) explain in their study that intrinsic motivation means performing an activity simply because it is interesting, brings enjoyment and is satisfying, as opposed to extrinsic motivation, which refers to doing an activity because it leads to an external outcome, e.g. fulfilment of role or public support. Besley et al. (2018) identify enjoyment and pleasure to be a consistent predictor of engagement in public communication of science within Attitude towards Engagement. Entradas et al. (2019) show that it is primarily intrinsic motivation which drives scientists to engage in public communication, and, e.g. in climate change, political orientations, academic productivity and awareness of controversy of the topic raises in the public domain were also important determinants. The literature within Entradas et al. (2019) splits extrinsic motives into "rewards", e.g. awards and prizes from participating in engagement activities, and "role", e.g. activities that arise from scientists' understanding of their role in public communication as academic researchers. However, Entradas et al. (2019) further mention that scientists engaging with the public were more likely to be highly motivated while also less likely to perceive extrinsic rewards as important. Therefore, while awards and prizes are not important drivers for those already engaging in public communication, may work as a barrier for those who do not engage, particularly for younger and less productive researchers (Entradas et al., 2019).

Summary of findings

The above literature demonstrated that Demographics, Attitude Toward Engagement and Audience, Perceived Norms, Self Efficacy, Response Efficacy and Perceived Enjoyment could impact TU Delft researchers' willingness to engage in public communication of science through online storytelling. Hence, the above literature review summarises that,

1. within the *Demographics* driver:
    - age is a predictor of engagement with the public through online storytelling, i.e. younger scientists are more likely to engage, while mid-career and older scientists are less

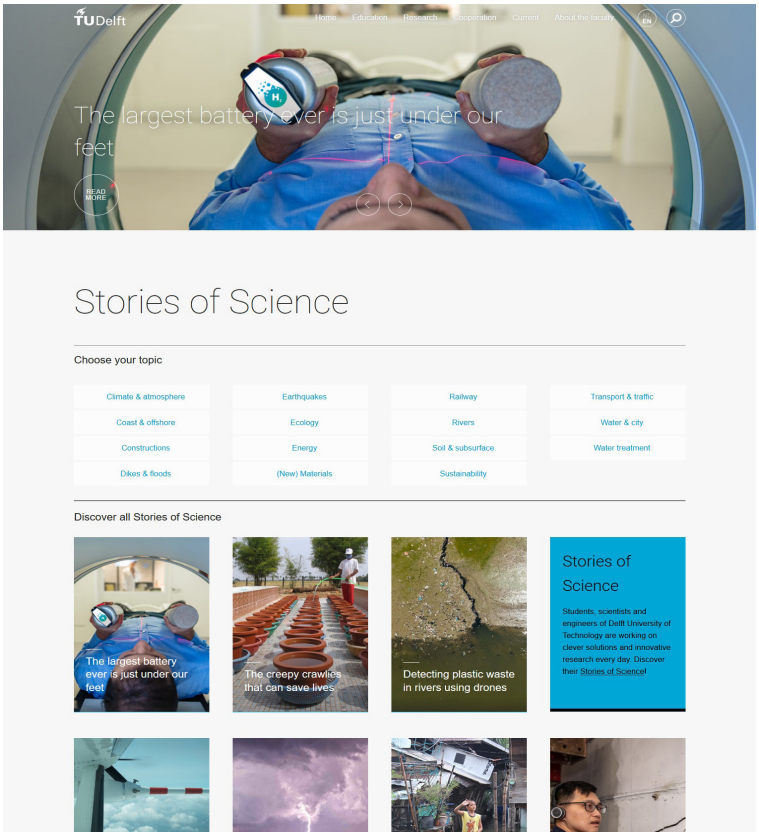
likely to do so;
    - scientific status is a predictor of engagement with the public through online storytelling and other media, i.e. more productive scientists are more likely to engage;
2. within the *Perceived Norms* driver, perceiving online storytelling and other media as acceptable and accepted by peers, is a predictor of engagement;
3. within *Attitude towards Engagement* driver, the quality of the experience is a strong predictor of engagement with the public in online storytelling as:
    - intrinsic motivation (*Perceived enjoyment*) can positively impact engagement with the public through online storytelling and other media,
    - extrinsic motivation can negatively impact engagement with the public through online storytelling and other media, especially for younger and less productive scientists;
4. Within the *Self-Efficacy* variable, time-demanding tasks are a strong predictor of scientists' willingness to engage with the public through online storytelling and other media, i.e. reducing time-demanding tasks can positively impact scientists' willingness to engage and vice-versa;
5. Within the *Response-Efficacy* variable, tracking engagement impact is a strong predictor of engagement with the public through online storytelling and other media, i.e. showing positive responses can positively impact scientists' willingness to communicate.

The following subchapter will investigate whether the predictors mentioned above are strong predictors of engagement, and can strengthen, or hamper, TU Delft researchers' attitude in co-creation of scientific storytelling within the TU Delft.

Attitude towards a similar platform

As the storytelling platform is under development, the analysis will assess which guidelines can best improve TU Delft researchers' attitude towards the soon to be released platform through an existing TU Delft-based non-profit storytelling platform. Such platform is Stories of Science, an online web-platform for external and, mostly, internal communication that enables TU Delft researchers of the Faculty Of Civil Engineering and Geosciences (CE&G) to engage in co-creation of scientific storytelling to promote cooperation within the faculty, as some researchers may lack a technical background to understand the topic in depth, and outside of it. Figure 4 proposes a screenshot of the web-platform (https://www.tudelft.nl/en/ceg/research/stories-of-science/).

Figure 4 - *A screenshot of the 'Stories of Science' storytelling platform.*



Since March 2016, the editorial team featured a total of 134 TU Delft researchers on the platform, divided into 45 PhD students (34 %) and 89 Scientific staff members (Postdocs, Professors and Researchers) (66 %) in 113 stories. According to Karlijn Spoor, a communication specialist within the CE&G faculty in charge of *Stories of Science*, the idea of the platform is to both propose stories that are scientifically true and attractive, while reducing time-demanding tasks for the TU Delft researchers to engage in co-creation of storytelling, giving them the last word upon publication and making the whole activity entertaining. This platform is used as a case study since, according to Meijer, the developers are using the User Interface (UI) and User Experience (UX) of *Stories of Science* as a blueprint to design and develop the new platform.

Technology Acceptance Model analysis

In the following section, this study is going to use the Technology Acceptance Model (TAM) (Davis, 1989) to assess TU Delft CE&G researchers' attitude towards Stories of Science. The TAM is the most widely applied model of users' acceptance and usage of technology (Venkatesh et al., 2003), and it originates from information system theories and predicts how and when individuals will adopt and use new technology (Davis, 1989; Davis et al., 1989), as when someone forms an intention to act, they will be free to act without limitation (Davis et al., 1992).

Figure 5 illustrates how each construct or variable affects each other within the TAM.

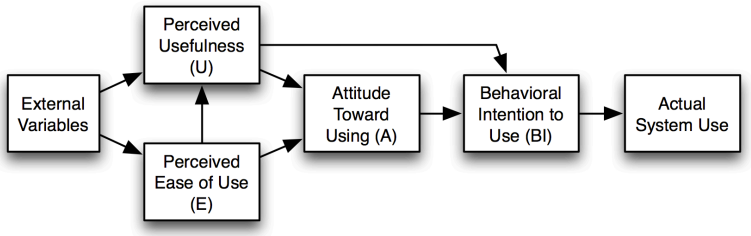


Figure 5 - *Version 1 of the Technology Acceptance Model (Davis et al., 1989).*

Perceived Usefulness (PU) is defined by Davis (1989) as "the degree to which a person believes that using a particular system would enhance his or her job performance", and Perceived Ease of Use (PEU) as "the degree to which a person believes that using a particular system would be free of effort". Both measures are relevant to understand the acceptance of new technologies, but perceived usefulness tends to have more influence on use than ease of use because this latter usually does not compensate for the absence of perceived usefulness of a given system (Davis, 1989). In this current study, Perceived Usefulness (PU) stands for TU Delft researchers' perception of the IT platform for doing internal and external communication. At the same time, the Perceived Ease of Use (PEU) investigates whether TU Delft researchers find the IT platform easy to use, attractive and relevant to enhance collaboration or innovation. In addition to PEU and PU, it is essential to investigate the Attitude towards Use (AU) of the platform, as Davis et al. (1992) mention that perceived enjoyment and perceived usefulness mediate the influence on perceived ease of use towards AU, and Besley et al. (2018) mentioned previously that the quality of the experience is a predictor of engagement within public communication of science. The Behaviour Intention (BI) construct, indicates an individual's requests and efforts to perform a behaviour, mediated by PU and AU, and it is strictly related to the type of platform.

As the TAM asserts that the influence of external variables upon user behaviour is mediated through user beliefs and attitudes (Davis et al., 1989), numerous factors can impact scientists' engagement in public communication of science. The predictors of engagement identified in the previous section are listed as external variables for this current study: (i) Perceived-Norms (PN), (ii) Self-Efficacy (SE), (iii) Intrinsic-Motivation (IM), (iv) Extrinsic-Motivation (EM), (v) Response-Efficacy (RE). Although Perceived-Norms seems to be a limited predictor of engagement in the study of Besley et al. (2018) and the platform is an internal news outlet, a more recent study from Besley et al. (2019) mention the importance of assessing whether a

communication tactic is ethically acceptable and acceptable to their peers. Self-Efficacy will include the findings related to the Demographic predictor since scientific status and age impacts academic productivity, and, consequently, the self-perception to be effective in engaging in public communication of science (Besley et al., 2018; Entradas et al., 2019). The study will further split "Perceived Enjoyment" into Extrinsic-Motivation (EM), and Intrinsic-Motivation (IM) and assessed separately within the questionnaire, since Davis et al. (1992) describe perceived usefulness as a form of extrinsic motivation. This choice should highlight whether extrinsic motivation does indeed work as a barrier, as mentioned by Entradas et al. (2019), or it can positively impact users' PU and PEU towards the storytelling platform. The study adapted the TAM with the above external variables as shown in Figure 6.

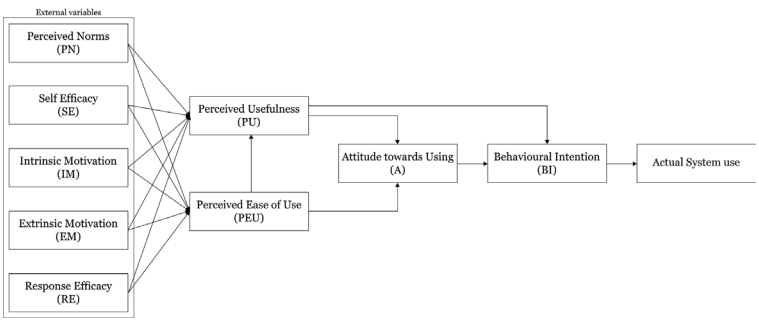


Figure 6 - *Proposed version of the TAM for this research project.*

The study developed a questionnaire with non-validated scales to assess CE&G TU Delft researchers' attitude towards Stories of Science. The study used the questionnaire within the study of Ibilit et al. (2019) as an example, the inputs of Meijer and Spoor, the hypothesis within the study of Besley et al. (2018), and the findings on intrinsic and extrinsic motivation within Entradas et al. (2019) to develop the questions. Despite some of the hypothesis within Besley et al. (2018) proved not to be strong predictors of engagement, the study included them since Dutch scientists may value predictors of engagement differently from US scientists. Page 75 of the appendix contains the full version of the questionnaire. Through the app Parantion, a sample of 477 TU Delft researchers of the CE&G faculty was contacted via email to take part in the questionnaire. A total of 31 valid responses were received for the questionnaire, equaling to a response rate of 6.5% within the sample, and 3.7 % within the entire faculty (31 out of 828 total CE&G researchers). The study grouped the respondents according to scientific status (i.e., academic position), knowledge of the platform, frequency of visits, experience in a publication of one or more stories, and media training, as shown in Table 2.

Profiles (N = 31)	Category	Frequency	Percentage %
Academic position	PhD student	13	42 %
	Scientific staff	18	58 %
New to the platform	Yes	3	10 %
	No	28	90 %
Visits*	Monthly	18	65 %
	Yearly	10	35 %
Featured	Yes	7	23 %
	No	24	77 %
Received media training	Yes	11	35 %
	No	20	65%

Table 2 - *Respondents' profiles from the CE&G faculty. * New users were excluded (N = 28).*

This division is meant to highlight if being part or not of a category improves or worsens TU Delft researchers' attitude towards the platform. This is motivated by PhD students' tendency to have fewer publications than Postdocs, Researchers and Professors (Scientific staff), by the TU Delft providing Media training to permanent employees (Scientific staff), and by a difference in frequency of visits (monthly or yearly). The questionnaire was designed with a 5-point Likert-type scale (Likert, 1932) (1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree, 5 = strongly agree). The means of Perceived-Norms (PN), Self-Efficacy (SE), Intrinsic-Motivation (IM), Extrinsic-Motivation (EM), Response-Efficacy (RE), Perceived Ease of Use (PEU), Perceived Usefulness (PU), Attitude towards Use (AU) and Behavioural Intention (BI) score between 7.23 to 17.68 (Table 3). The inversion of trend within Self-Efficacy (SE) is motivated by question 2 within that construct: "*I consider my work difficult to explain to non-experts and feature it on Stories of Science*" which expected a lower score for a higher willingness to engage. It is also worth mentioning that PhD students and untrained researchers responded to 4 out of 5 questions within Self-Efficacy (SE), as they have never received media training. Same goes for Response-Efficacy (RE), where unfeatured and new users responded to 3 out of 4 questions since they were never featured on the platform.

In the next phase of the analysis, the study calculates the Cronbach's alpha (Cronbach, 1951), i.e. a measure of internal consistency or reliability of each variable and construct to provide evidence that the Likert Type items form an internally reliable subscale, e.g. the Likert Type items are homogeneous and measuring the same concept. The study uses DeVellis' work (2017) to interpret what makes a good alpha coefficient.

	Mean										
	Total	**PhD students**	**Scientific staff**	**Featured**	**Non featured**	**Media training**	**No training**	**New user**	**User**	**Monthly**	**Yearly**
PN	10.39	10.62	10.22	10.86	10.25	10.09	10.55	9.67	10.37	11.00	9.50
SE*	14.05	11.31	13.74	13.24	14.33	13.73	11.05	14.83	13.97	13.44	15.00
IM	7.23	7.23	7.22	7.86	7.04	7.00	7.64	5.67	7.30	7.50	7.20
EM	9.97	11.08	9.17	11.14	9.63	10.40	9.18	9.33	9.97	10.00	10.10
RE*	15.42	16.15	14.89	15.14	11.79	14.70	15.90	9.67	15.45	15.83	15.50
PEU	17.68	17.77	17.61	18.86	17.33	17.73	17.65	15.00	17.77	18.39	17.20
PU	14.39	14.85	14.06	14.71	14.29	13.82	14.70	12.33	14.43	14.78	14.30
AU	11.39	12.31	10.72	11.71	11.29	10.82	11.50	8.67	11.50	11.78	11.50
BI	13.39	13.62	13.22	14.43	13.08	12.91	13.65	12.00	13.47	13.83	13.00

Table 3 - *Mean and standard deviation of measurable items. *Denotes variables with conditional questions, SE-3 and RE-3, where respondents may reply with NA.*

This work considers Excellent for $\alpha > 0.90$, Very Good for $\alpha > 0.80$, Respectable for $\alpha > 0.70$, Minimally Acceptable for $\alpha > 0.65$, Undesirable for $\alpha > 0.60$, and Unacceptable for $\alpha < 0.60$. Table 4 shows that Perceived-Norms (PN), Self-Efficacy (SE) and Extrinsic-Motivation (EM) are unacceptable, while the other constructs are acceptable ($\alpha > 0.60$). Hence, these three constructs and the underlying eleven items are unreliable.

	N of items	**Mean (SD) per construct**	**AVE**	**CR**	**Cronbach's alpha**
PN	3	3.36 (.60)	0.38	0.59	0.57
SE	5 (4)	2.81 (.77)	0.27	0.50	0.40
IM	2	3.61 (.23)	0.77	0.87	0.70
EM	3	3.32 (.34)	0.41	0.56	0.25
RE	4 (3)	3.86 (.46)	0.53	0.79	0.78
PEU	5	3.54 (.25)	0.28	0.65	0.68
PU	4	3.60 (.47)	0.58	0.85	0.75
AU	3	3.80 (.15)	0.78	0.91	0.85
BI	4	3.35 (.48)	0.66	0.89	0.82

Table 4 - *Average variance extracted (AVE), composite reliability (CR) and Cronbach's alpha.*

To further validate whether the questionnaire, this study calculates the composite reliability (CR) and that the average variance extracted (AVE) of each construct. The former, CR, is a measure of internal consistency in scale items, while the latter, AVE, measures the amount of variance that is captured by a construct with the amount of variance due to measurement error (Hair et al., 2006). CR and AVE should be respectively higher

than 0.70 and 0.50 to be valid (Hair et al., 2006). Given that Perceived-Norms (PN), Self-Efficacy (SE), Extrinsic-Motivation (EM), and Perceived Ease of Use's (PEU) AVE and CR score respectively below 0.50 and 0.70, it makes a Structural Equation Modelling analysis unreliable to provide with proper insights on these constructs in the overall sample. Perceived-Norms (PN), Self-Efficacy (SE) and Extrinsic-Motivation (EM) are unreliable to determine whether there are statistically significant differences in the data, and should not be used as guidelines for the gamified design. The following part of this project will focus on analysing whether there are statistically significant differences among the constructs with an acceptable Cronbach's alpha, namely Intrinsic-Motivation (IM), Response-Efficacy (RE), Perceived Ease of Use (PEU), Perceived Usefulness (PU), Attitude towards Use (AU) and Behavioural Intention (BI). The study used arithmetic means and unpaired t-tests, since the groups present different number of responses, to examine whether academic productivity (Table 5), media training (Table 6), knowledge of the platform (Table 7), frequency of visits (Table 8), or being featured on the platform (Table 9) played a role in the TAM subscales levels. The software SAS was used to run the unpaired t-tests.

	Mean (SD)			
	PhD students	**Scientific staff**	**t**	**p**
IM	7.23 (.11)	7.22 (.31)	.11	.912
RE	16.15 (.43)	14.89 (.49)	7.47	.001**
PEU	17.77 (.23)	17.61 (.27)	1.73	.094
PU	14.85 (.38)	14.06 (.57)	4.34	.002**
AU	12.31 (.09)	10.72 (.25)	21.84	.001**
BI	13.62 (.50)	13.22 (.46)	2.30	.029*

Table 5 - *The mean of subscales according to respondents' academic position (and academic productivity). * 0.05 significance level ** 0.01 significance level.*

Table 5 shows there is a statistical difference between the mean of PhD students' Response-Efficacy (RE), Perceived-Usefulness (PU) and Attitude towards Use (AU) and the Scientific staff ($p < 0.01$), and mild statistical different in Behavioural Intention (BI) ($p < 0.05$). There was no statistically significant difference between the means of PhD students and the Scientific staff's Perceived Ease of Use (PEU).

	Mean (SD)			
	Media training	**No training**	**t**	**p**
IM	7.64 (.39)	7.00 (.14)	6.67	.001**
RE	14.70 (.70)	15.90 (.40)	6.10	.001**
PEU	17.73 (.24)	17.65 (.29)	.77	.443
PU	13.82 (.77)	14.70 (.35)	4.39	.001**
AU	10.82 (.58)	11.50 (.32)	4.23	.001**
BI	12.91 (.30)	13.65 (.57)	3.99	.001**

Table 6 - *The mean of subscales according to receiving media training. ** 0.01 significance level.*

Table 6 shows that there is a statistical difference between the mean of those who received media training and those who did not within Intrinsic-Motivation (IM), Response-Efficacy (RE), Perceived-Usefulness (PU) and Attitude towards Use (AU) and Behavioural Intention (BI) ($p < 0.01$). There was no statistically significant difference between the mean of Perceived Ease of Use (PEU).

	Mean (SD)			
	New users	**Users**	**t**	**p**
IM	5.67 (.24)	7.30 (.21)	12.64	.001**
RE	9.67 (.84)	15.45 (.43)	20.25	.001**
PEU	15.00 (-)	17.77 (.26)	18.17	.001**
PU	12.33 (.50)	14.43 (.44)	7.79	.001**
AU	8.67 (.19)	11.50 (.15)	30.43	.001**
BI	12.00 (.61)	13.47 (.47)	5.03	.001**

Table 7 - *The mean of subscales according to new or current users. ** 0.01 significance level.*

Table 7 shows that there is a statistical difference between the mean of new users and current users within Intrinsic-Motivation (IM), Response-Efficacy (RE), Perceived Ease of Use (PEU), Perceived-Usefulness (PU), Attitude towards Use (AU), Behavioural Intention (BI) constructs ($p < 0.01$).

	Mean (SD)			
	Monthly users	**Yearly users**	**t**	**p**
IM	7.50 (.20)	7.20 (.28)	3.29	.002**
RE	15.83 (.34)	15.50 (.68)	1.72	.097
PEU	18.39 (.33)	17.20 (.28)	9.62	.001**
PU	14.78 (.51)	14.30 (.43)	2.52	.018*
AU	11.78 (.21)	11.50 (.06)	4.09	.001**
BI	13.83 (.49)	13.00 (.44)	4.45	.001**

Table 8 - *The mean of subscales according to monthly or yearly users.*
** 0.05 significance level.*
*** 0.01 significance level.*

Table 8 shows that there is a statistical difference between the mean of monthly and yearly users within Intrinsic-Motivation (IM), Perceived Ease of Use (PEU), Attitude towards Use (AU) and Behavioural Intention (BI) ($p < 0.01$), and mild statistical difference for Perceived-Usefulness (PU) ($p < 0.05$). There was no statistically significant difference between the means of Response-Efficacy (RE).

	Mean (SD)			
	Unfeatured	**Featured**	**t**	**p**
IM	7.04 (.21)	7.86 (.30)	8.25	.001**
RE	11.79 (.58)	15.14 (.38)	14.32	.001**
PEU	17.33 (.27)	18.86 (.22)	13.68	.001**
PU	14.29 (.37)	14.71 (.87)	1.89	.068
AU	11.29 (.17)	11.71 (.16)	5.82	.001**
BI	13.08 (.52)	14.43 (.36)	6.39	.001**

Table 9 - *The mean of subscales according to unfeatured or featured users.*
*** 0.01 significance level.*

Table 9 shows that there is a statistical difference between the mean of new user and user within Intrinsic-Motivation (IM), Perceived Ease of Use (PEU), Attitude towards Use (AU) and Behavioural Intention (BI) ($p < 0.01$), and a mild difference for Perceived Usefulness (PU) ($p < 0.05$). There was no statistically significant difference between the mean of Response-Efficacy (RE) ($p > 0.05$). The next section will discuss the results.

Results discussion

Among the external variables that can affect Perceived Ease of Use (PEU) and Perceived Usefulness (PU) and, consequently, the other variables in the TAM: (i) Perceived-Norms (PN), Self-Efficacy (SE) and Extrinsic-Motivation (EM) do not provide insights on whether they can impact differently the analysed groups due to an undesirable Cronbach's alpha ($\alpha < .60$) (Cronbach, 1951; De Vellis, 2017); (ii) Response-Efficacy (RE) ($M = 3.86$, $SD = .46$) and Intrinsic Motivation (IM) ($M = 3.61$, $SD = .23$), score the highest means and present statistically significant differences among the identified groups. These results proved to be in line with the previous chapter's findings, as, in regards to response efficacy, Besley et al. (2018) mention that the outcome of the communication, i.e. quality and impact, is a strong predictor of scientists' willingness to engage. In regards to intrinsic motivation, the findings also proved to be in line with the study of Entradas et al. (2019), who mention that intrinsic motivation is stronger in engaging TU Delft researchers to engage in public communication of science than extrinsic motivation as intrinsic motivation ($M = 3.61$, $SD = .23$) scored higher than extrinsic motivation ($M = 3.32$, $SD = .34$) within the interviewed sample. An extremely significant statistical difference ($p < 0.01$) within the two-tailed p-value supported the above results. Response efficacy scored the highest for PhD students ($M = 16.15$, $SD = .43$), while intrinsic motivation scored highest for featured Civil Engineering & Geoscience (CE&G) TU Delft researchers ($M = 7.86$, $SD = .30$). Beside Response Efficacy (RE) students also scored the overall highest means for Perceived Usefulness (PU), Attitude towards Use (AU) and Behavioural Intention (BI). Having higher means on the above constructs is consistent with the findings of Besley et al. (2018), who mention that younger researchers are more willing to engage than older groups in public communication of science through online media. Besides Intrinsic Motivation (IM), featured researchers also scored the highest in Perceived Ease of Use (PEU). Having the featured researchers scoring the highest value in Intrinsic-Motivation (IM) is consistent with Besley et al. (2018), who mentions that the quality of experience, i.e. the scientist has fun communicating to the public, is a positive predictor of willingness to engage, and Entradas et al. (2019), who mention that intrinsic motivation is stronger in motivating scientists versus extrinsic motivation.

Perceived Norms (PN) proved not to be particularly relevant in predicting willingness to engage, and scored lower than response efficacy and intrinsic motivation. This finding is congruent with the study of Besley et al. (2018), but it is incongruent with a future study of Besley et al. (2019), who claim that in a future study the ethics of the communication should always be assessed. This

discrepancy can be explained since the storytelling platform is an internal, non-profit news outlet with a portfolio of 113 stories co-created with more than 140 CE&G TU Delft researchers. It is run by TU Delft science communicators, who hold a more positive reputation compared to journalists (McKinnon et al., 2019) that earn CE&G TU Delft researchers' trust by giving them the last word in the communication outcome (Peters, 2013) and reducing time-demanding tasks (Besley et al., 2018). The reduced time-demanding tasks also potentially justify why Self-Efficacy (SE) proved not to be a strong predictor of engagement within this study, despite different claims from Besley et al. (2018) and Besley et al. (2019). According to the inputs from Meijer, the researcher has to dedicate around two hours to be interviewed, edit the piece, take pictures and give the final go. All within flexible deadlines. In this way, the editorial team further helps in lowering the barriers to engaging for CE&G TU Delft researchers within the co-creation of stories, a critical factor that influences willingness to engage according to Besley et al. (2018). The next section will use the results to define the important predictors of engagement to later translate them into guidelines within Chapter 3.

Identified predictors

The Response-Efficacy (RE) variable seems to be the best option to improve TU Delft researchers' attitude towards online storytelling, as it has the highest mean among both the external variables and the TAM constructs ($M = 3.86$, $SD = .46$), and it presents statistically significant differences among its groups. A difference in p-value between Response-Efficacy (RE) and Intrinsic-Motivation (IM) ($M = 3.61$, $SD = .23$), the second-highest and acceptable ($\alpha > .60$) external variable, also supports such choice since the two-tailed p-value is lower than 0.01 ($p < 0.01$), making this difference extremely statistically significant. Such finding means that the gamified design should focus on translating ways to show and track the impact of communicating science to the public. Table 10 presents each group weighted average related to Response-Efficacy (RE).

	Weighted average									
	PhD students	Scientific staff	Featured	Non featured	Media training	No training	New user	User	Monthly	Yearly
RE	**4.03**	3.72	3.67	**3.98**	3.79	**3.93**	3.22	**3.86**	**3.96**	3.88

Table 10 - Statistical significant differences (green) or non-statistical significant differences (orange) of a particular group of TU Delft researchers' RE.

Following De Vellis's work (2017), it can be observed that all the groups presented high level of agreement based on their average weighted score ($4.2 < \mu < 3.4$), except for new users who present an average level of agreement ($3.4 < \mu < 2.6$). Hence, Response-Efficacy (RE) proves to be a robust predictor of engagement for all the groups, except for new users, with particu-

lar statistical significant difference for PhD students, untrained researchers, unfeatured researchers and current users. During the translation of the guidelines within Chapter 3, and the design phase within Chapter 4, intrinsic motivation should also be considered, since it is the second-highest variable and presents extreme statistically significant difference ($p > 0.01$) compared to extrinsic motivation ($M = 3.32$, $SD = .34$). Figure 7 proposes a customized version of the TAM for this study. According to the results, Response-Efficacy (RE) and Intrinsic Motivation (IM) are direct predictors of Perceived Ease of Use (PEU) and Perceived Usefulness (PU), and the Response Efficacy (RE) is the most appropriate variable to increase TU Delft researchers' attitude to engage in co-creation of online storytelling.

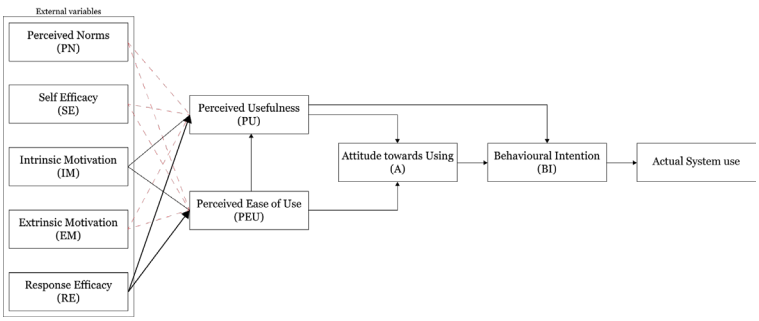


Figure 7 - *Within the TAM, Response-Efficacy (RE) and Intrinsic Motivation (IM) are strong predictors of engagement.*

The next subchapter will be used to summarise the findings of this chapter.

Chapter summary

Among the external variables that can affect Perceived Ease of Use (PEU) and Perceived Usefulness (PU) and, consequently, the other variables in the TAM: (i) Perceived-Norms (PN), Self-Efficacy (SE) and Extrinsic-Motivation (EM) do not provide insights on whether they can impact differently the analysed groups due to an undesirable Cronbach's alpha ($\alpha < .60$) (Cronbach, 1951; De Vellis, 2017); (ii) Intrinsic-Motivation (IM) and Response-Efficacy (RE), score the highest means and present statistically significant differences among the identified groups. The next sub-paragraph will use the results to define the guidelines of the gamification.

This chapter used a literature review to determine which factors are potential strong predictors of engagement in co-creation of online scientific storytelling for TU Delft researchers. It implemented these factors as external variables within an analysis of Stories of Science, a TU Delft-based non-profit storytelling platform, with the Technology Acceptance Model to determine which can best positively influence TU Delft researchers' attitude towards co-creation of online storytelling. The results of the TAM questionnaire, provided to a sample to TU Delft

researchers, proved that response efficacy is a direct predictor of Perceived Ease of Use (PEU) and Perceived Usefulness (PU) for the storytelling platform. The study will consider Response Efficacy as the main guideline to gamify the platform in the following chapters. Intrinsic Motivation (IM) also proved to be a strong predictor of PEU and PU, and the design should favour it over extrinsic motivation. Hence, to reply to the first sub-research question, **these factors impact TU Delft researchers' willingness to engage in public communication of science through online scientific storytelling:**

1. Tracking the impact of engagement through Response Efficacy (RE) since:
    - RE is a strong predictor of engagement within co-creation of online scientific storytelling for all the groups;
    - RE is a predictor of engagement within co-creation of online scientific storytelling for new users;
    - RE is a robust predictor of engagement with statistically significant differences for PhD students, untrained researchers, featured researchers and current users;
2. Intrinsic motivation is a strong predictor of engagement and should be preferred over extrinsic motivation.

The following chapter will translate the predictors of engagement from this chapter into guidelines for the conceptual design of the gamification. The predictors identified above will guide the design process and help to evaluate if the platform is effective in motivating users to pitch story ideas.

Chapter 3

Design guidelines

Chapter 3 begins with a literature review within gamification to understand how to translate Response Efficacy within gamification best. Findings discuss that points, leaderboards, badges and social points seem to motivate users in similar contexts, e.g. idea generation competitions, and are based on internalised extrinsic motivation. Motivating users through this type of motivation can boost performances without negatively impacting intrinsic motivation. Consequently, the study analysed Stories of Science and "r/place", a web social experiment aimed at fostering cooperation among users of a social network, to evaluate which gamification elements to implement in the conceptual design through the Octalysis framework (Chou, 2015). Upon finalising the analysis, the study used a morphological chart to generate scenarios and finalise the conceptual design of the gamified experience. The inputs from the literature review, the analysis of Stories of Science and r/place, the idea to use a force graph model to represent the impact of communication within the TU Delft and balanced gamification, developed some scenarios that merge into the conceptual design. The resulting conceptual design implements each core drives of the Octalysis, specifically developing gamification elements within the Social Influence and the Accomplishments core drives, to guide the design phase.

Define guidelines

This chapter aims at answering the second sub-research question: *what guidelines can be drawn from the identified factors, design literature and gamification literature to guide the gamified design to improve TU Delft researchers' willingness to engage in online scientific storytelling through the TU Delft-based storytelling platform?* The next subchapter will define the guidelines through literature and an analysis with the Octalysis.

Gamification literature

Deterding (2014) mentions in his paper the importance of motivation as the main strategic lever when designing gamified interactions, creating a target experience that provides a target audience with planned, goal-directed and self-determined actions. According to the inputs from Chapter 2, such target experience should focus on motivating TU Delft researchers to submit story ideas and use the storytelling platform through the response efficacy of their engagement, and on intrinsic motivation through what Mekler et al. (2017) define as autonomy-oriented feedback. In regards to response efficacy, Besley et al. (2018) mention in their study that this variable depends on positive or negative reactions of an audience and is bound to a "reward", e.g. number of reTweets. Since Chou (2015) mentions the importance of balancing the experience between intrinsic and extrinsic motivation to attract differently motivated users, and Mekler et al. (2017) mention that gamified experience should balance both control-oriented feedback and autonomy-oriented feedback, one of the guidelines of the gamified experience is to motivate users through internalised extrinsic motivation. Internalised extrinsic motivation is a type of goal-driven extrinsic motivation similar to intrinsic motivation (Ryan & Deci, 2000), which can influence user behaviour and boost performance without negatively impacting intrinsic motivation (Mekler et al., 2017). Therefore, points, levels and leaderboards, are part of internalised extrinsic motivation, as they do not impair intrinsic motivation in contrast to previous findings (Mekler et al., 2017), and could be optimal to represent users' response efficacy of their communication efforts. Also, Schenier (2015) discusses in his study that, when gamifying idea competitions, a concept similar to submitting story ideas, he noticed that social points, game points and exchange were the most appreciated elements among the participants. Scheiner (2015) further discusses that badges and levels also played a role, if balanced and providing an increase in difficulty. Scheiner (2015) also mentions that narrative was not well welcomed among participants, but goals, nevertheless, played an important part in the study.

The elements mentioned above fit within the *Accomplishment* and the *Social Influence* core drives by Chou (2015) within the Octalysis framework. Hence, focusing on implementing

gamified elements within these two core drives seems to greatly benefit the design in the coming projects. The next sections will focus on analysing the current effectiveness of *Stories of Science* in motivating its users and using such core drives, and a case study in a similar context named "Place" to understand how a balanced gamified experience correctly translate these core drives into gamification elements. The next section will use the Octalysis framework to analyse *Stories of Science*.

Analysis of Stories of Science

As mentioned in the study of Mora et al. (2017) in Chapter 1, the Octalysis (Chou, 2015) is a suitable framework to analyse existing gamified designs. By using the scoring system developed by Chou (2015) (http://www.yukaichou.com/octalysis-tool/) to analyse the platform core drives in motivating its users, the Octalysis diagram of *Stories of Science* is illustrated in Figure 8.

Figure 8 - *Illustrated Octalysis for Stories of Science, based on Chou's analysis tool (2015).*

According to the scoring system, the experience seems out of balance as it is heavily focused on White Hat Core Drives; this means that users feel great and empowered but do not have a sense of urgency to commit the desired actions. Besides, it can be observed that the right brain is more strongly stimulated, and, consequently, the platform relies more on intrinsic motivation. Adding more feelings of accomplishment and more controlled limitations could improve the experience of using the platform and further motivate new users through extrinsic motivations, e.g. gaining rewards. The analysis shows how each element affect users' motivation:

1. the *Meaning* core drive seems to motivate TU Delft researchers,
    - by displaying the importance of research and of communicating it to the public through Humanity hero (Chou, 2015),

- by showing that they can be part of a small circle of privileged people, a concept named Elitism by Chou (2015);

2. the *Avoidance* core drive seems to motivate TU Delft researchers, by giving a small sense of urgency to check the platform every once in a while through the FOMO punch (Chou, 2015);
3. the *Social Influence* core drive seems to motivate TU Delft researchers,
   - by displaying the published story as Tout flag on the researcher's page (Chou, 2015),
   - by joining the researchers published as Social treasure (Chou, 2015);
4. this gamification element also returns as a badge (Chou, 2015) through the *Accomplishment* core drive to motivate TU Delft researchers;
5. it implements extrinsic motivation through the *Scarcity* core drive as users have to go through Torture breaks to read new stories (Chou, 2015).

The above guidelines will be implemented during the design of the conceptual design since the new design aims at improving the elements already existing elements within Stories of Science. The guidelines should also point to balance extrinsic and intrinsic motivation, while increasing the Black Hat core drive. The next section will instead focus on analysing a case study of a balanced experience in a similar context to the storytelling platform.

Analysis of Reddit Place

"Place" was a collaborative project and social experiment hosted on the social networking site Reddit on April 1st, 2017 (Machkovech, 2019). The idea of this social experiment was to allow the social network users to anonymously colour a pixel

Figure 9 - *A screenshot of the canvas created on the subreddit r/place (Machkovech, 2019).*

anywhere on a 1000×1000 pixels white canvas, choosing from a 16-colours palette. After the pixel was coloured, a five to twenty minutes lockout forced the user to wait before colouring a different or the same pixel. Several works of pixel art were created as a result of the experiment, varying from fictional characters and internet memes to patriotic flags and recreations of famous pieces of artwork. The experiment ended on April 3rd, 2017, with over 1 million users participating in the project. Figure 9 shows a screenshot of the final artwork. This example is fascinating as users and subreddit communities that exist independently took notice of other communities on Reddit, and had to cooperate or compete with them to co-create the final canvas, and satisfy users' belief that a certain action, even if small, has an impact within a broader context. Such description is similar to Meijer description provided in Chapter 1, since TU Delft researchers may be unaware of what happens within the university and their relation within the TU Delft. According to the analysing with the Octalysis in Figure 10, the gamified experience presents a balanced design.

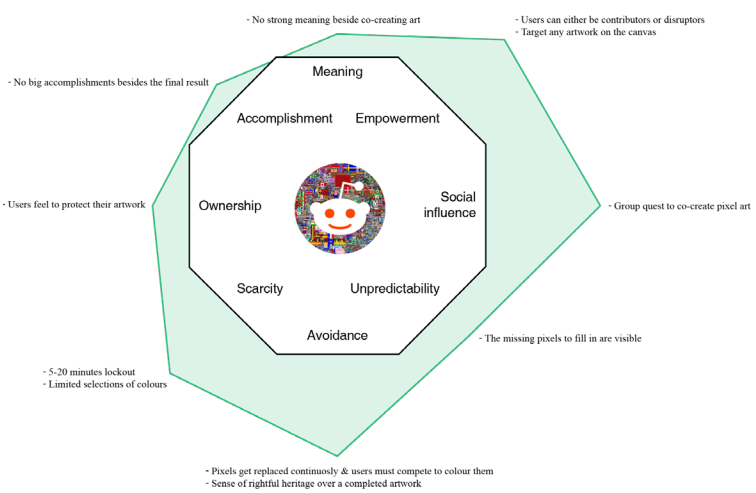


Figure 10 - *The Octalysis for r/place, calculated based on Chou's instructions (2015).*

"Place" seems to implement the three intrinsic motivation core drives, i.e. Empowerment, Social Influence and Unpredictability, while balancing the experience with extrinsic drives through Scarcity and Ownership. Specifically, the experience implements each core drive as follows:

1. the *Empowerment* core drive uses,
    - Choice perception (Chou, 2015) to let users assume the role of (i) contributors, participating to co-design a pixel artwork, or (ii) disruptors, by hampering the realization of one or more artwork,
    - Meaningful choices to let users pick which artwork to colour,
2. the *Social Influence* core drive uses Group quests (Chou,

2015) to foster cooperation among users to co-create pixel art;

3. the *Unpredictability* core drive uses Glowing choices (Chou, 2015) by giving visual cues of which pixels are missing;
4. the *Scarcity* core drive uses,
   - Torture breaks (Chou, 2015) by forcing users through a five to twenty minutes lockout before placing another pixel,
   - Magnetic caps (Chou, 2015) by forcing users to place only one pixel within a 16-colours palette;
5. the Avoidance core drive uses,
   - the Rightful heritage (Chou, 2015) by stopping other users from ruining a co-created artwork,
   - the FOMO punch (Chou, 2015) by the constant missed opportunities within the canvas,
   - the Evanescent opportunities (Chou, 2015) by letting users compete to colour pixels;
6. the *Ownership* core drive uses the Protector quest (Chou, 2015) by making users care for their artwork and protecting it;

The study will use these guidelines in the next section, where the study will focus on defining the elements to include in the design through a morphological chart.

Translate guidelines

As mentioned in the Methods subchapter within Chapter 1, the morphological chart can a great design tool to generate ideas analytically and systematically for the concept design and choose among the best available options per core drives. According to Cross (1989), the various functions and subfunctions of a product can be established through a function analysis, yielding a matrix of functions and options, as explained in Figure 11.

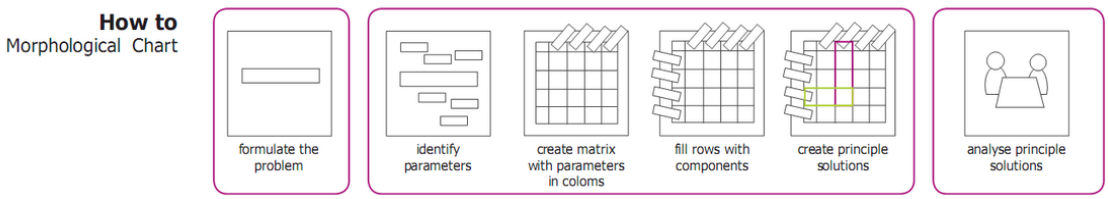


Figure 10 - *Steps to follow to use a morphological chart.*

The next sections will follow each step of the Morphological chart and conclude with the conceptual design of the gamified experience.

Formulating the problem

By starting from formulating the problem, it can be said that the idea of the gamified design is **to encourage TU Delft researchers to proactively contact the editorial team to engage in storytelling by showing the response efficacy of their and other users' engagement.** The next step regards identifying the functions. By following the functions defined within the Octalysis core drives (Chou, 2015), and the inputs from the literature review and the above analyses, *Accomplishment* and *Social Influence* core drives are the ones who should be given major attention during the design phase, while balancing intrinsic motivation with elements from extrinsic motivation. After having established these points, the next section will identify the design parameters.

Identify the parameters

Based on logic and personal preference, an interesting way to plot response efficacy is through force graphs model. The literature within Haleem et al. (2019) illustrated the force-directed graph as a force model to avoid node occlusions and edge crossings, and clustering-based graph layout techniques are designed to preserve the cluster structures of nodes as shown in Figure 12.

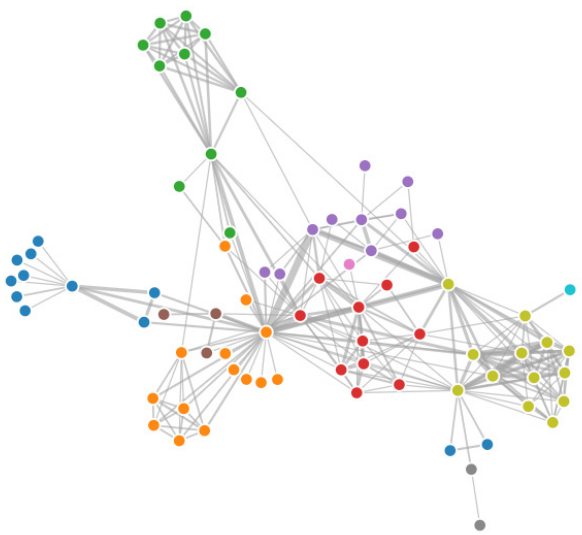


Figure 12 - *Sample of a force-directed graph generated through the JavaScript framework D3.*

Since Meijer mentioned that the storytelling platform target is to foster collaboration and innovation within the TU Delft, visualizing the TU Delft researchers within a network can help give a quick understanding of which researchers are related to each other (e.g., by faculty, department or research topic). The idea of the force graph is that the more a researcher publishes stories or creates connections, the more force he/she exerts a pull force over the other researchers, showing his/her importance within the TU Delft. Based on logic and personal preference, such connections can happen through tags. A tag is a piece of JavaScript code that enables the collection of unique information across a website and can be useful to group stories under the

same tag. This element can help users thoroughly in identifying stories that share similar topics within departments, faculties or the entire university and understand at a glance through the shared connections which peers are working on a similar topic, and in which department and faculty they are located. Gamifying this option can also help to get a grasp of the possible connections among different topics and give interesting insights, as shown in Figure 13.

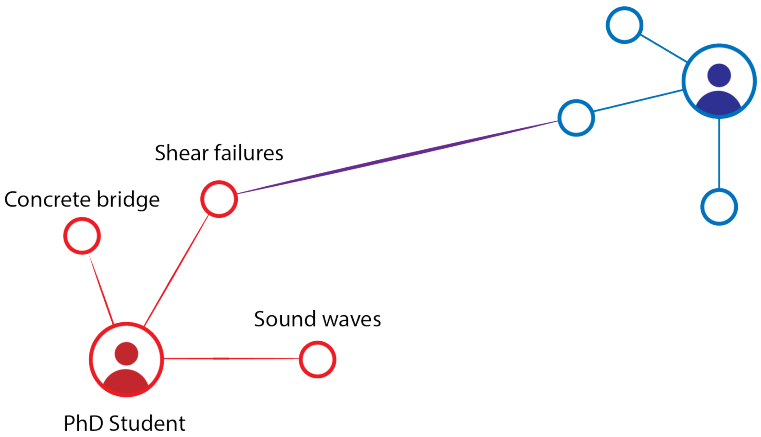


Figure 13 - *Concept image for showing a connection among tags.*

Components and principle solutions

The study will now generate scenarios based on the literature review, the Octalysis analyses and identified parameters within the force graph model to generate the conceptual design through the Morphological chart. The analyses are elaborated as follows:

1. According to the literature review, plotted on the morphological chart in **red**, the gamified should implement:
   - Points, leaderboards and badges within the *Accomplishment* core drive,
   - and Social treasures within the *Social Influence* core drive.

2. According to the inputs from the analysis of Stories of Science, plotted on the morphological chart in **orange**, the gamified experience should implement:
   - Humanity hero and Elitism within the *Meaning* core drive,
   - FOMO punch within the *Avoidance* core drive,
   - Tout flags and Social treasures within the *Social Influence* core drive,
   - Badges within the *Accomplishments* core drive,
   - and Torture breaks within the *Scarcity* core drive.

3. According to the inputs from the analysis of r/place, plotted on the morphological chart in **green**, the gamified experience should implement:
   - Rightful heritage, the FOMO punch and Evanescent

opportunities within the *Avoidance* core drive,
- Torture breaks and Magnetic within the *Scarcity* core drive,
- Choice perception and Meaningful choices within the *Empowerment* core drive,
- Protector quests within the *Ownership* core drive,
- Group quests within the *Social influence* core drive,
- and Glowing choices within the *Unpredictability* core drive.

4. According to personal preference, logic and to balance the gamification within the Octalysis analysis, plotted on the morphological chart in **blue**, the gamified experience should implement:
   - Milestone unlock within the *Empowerment* core drive, as being featured gives the users added actions compared to unfeatured users;
   - Thank-you economy within the *Social Influence* core drive, as publishing stories and suggesting connection within the force graph model can benefit multiple users;
   - Glowing choices and Rolling rewards within the *Unpredictability* core drive, by suggesting connections among tags and users, and providing random rewards to attract new users or further motivate current users to perform actions on the platform;
   - Collection sets within the *Ownership* core drive, as different types of badges are excellent to identify different types of response efficacy.
   - Appointment dynamics within the *Scarcity* core drive, as certain connection can happen within a limited time.
   - Free lunch within the *Meaning* core drive, as being recommended by a user brings benefit to both the existing and the new user.

Table 11 visualizes the morphological chart with the different paths highlighted per construct. In the next phase, the Octalysis framework will be used to propose a conceptual design, evaluate such design and compare with the current design of Stories of Science and r/place.

Conceptual design evaluation

Figure 14 illustrates the Ocalysis analysis of the conceptual design, specifying how each gamification element is implemented within each core drive. The design presents a predominance in using the *Social Influence* and *Accomplishment* core drives, with high values for Meaning, Avoidance and Empowerment. Intrinsic motivation is dominant over extrinsic motivation, in accordance with the results from Chapter 2, but is balanced within the analysis. Black and White Hat are balanced according

Empowerment	Boosters	Milestone unlock	Choice perception	Meaningful choices					
Social Influence	Mentorship	Group quests	Brag button	Tout flags	Social treasures	Thank you economy	Conformity anchor	Water coolers	Social prods
Unpredictability	Glowing choice	Mystery box	Easter egg	Rolling rewards					
Accomplishment	Progress bar	Badges	Social points	Leaderoard	Badges	Game points			
Ownership	Build from scratch	Collection sets	The Alfred effect	Protector quests	Collection sets				
Scarcity	Magentic caps	App. dynamics	Torture breaks	Evolved UI	App. dynamics				
Meaning	Narrative	Humanity hero	Elitism	Beginner's luck	Humanity hero	Free lunch			
Avoidance	Rightful heritage	FOMO punch	Countdown timers	Evanescent opportunity	Status quo	S. C. P.			

Table 11 - *Morphological chart plotting core drives on the x-axis and game techniques on the y-axis, while the green cells highlight the selected elements per Octalysis core drives (Chou, 2015).*

to Chou's (2015) analysis tool. The resulting guidelines from each core drive will be explained within the next subchapter. Figure 15 maps the Octalysis of *Stories of Science*, *r/place* and the conceptual design on top of each other. The *Social influence* core drive of *r/place* and the conceptual design are congruent, showing a potential substantial similarity in the social component of the two gamified designs as both rely on social quests and social treasures. Same goes for *Avoidance*, which is a little bit stronger within *r/place*, as the conceptual design is meant to instil

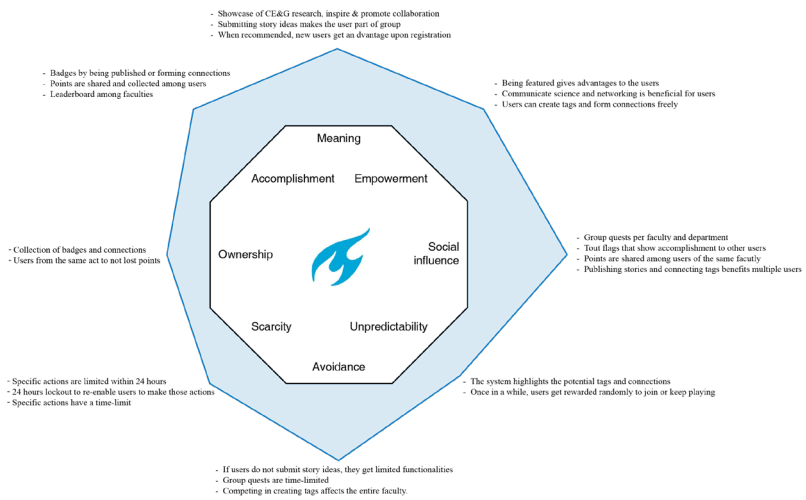


Figure 14 - *Analysis of the suggested new design through the Octalysis (Chou, 2015).*

a sense of urgency within the user. *Meaning*, *Accomplishment* and the *Ownership* core drives are more developed than the previous designs, showing how the experience relies on extrinsic motivation through *Ownership*, and through internalised extrinsic motivation through *Accomplishments*. Response efficacy is translated within *Accomplishments* by letting users achieve points, badges and compete among faculties. *Scarcity*

got reduced compared to *r/place*, since the conceptual design solely implements lockouts and limited actions. Unpredictability is slightly stronger within *r/place* than the conceptual design, as the conceptual design provides users with rolling rewards to attract new or inactive users, and highlights potential similar tags. The following subchapter will summarise this chapter findings.

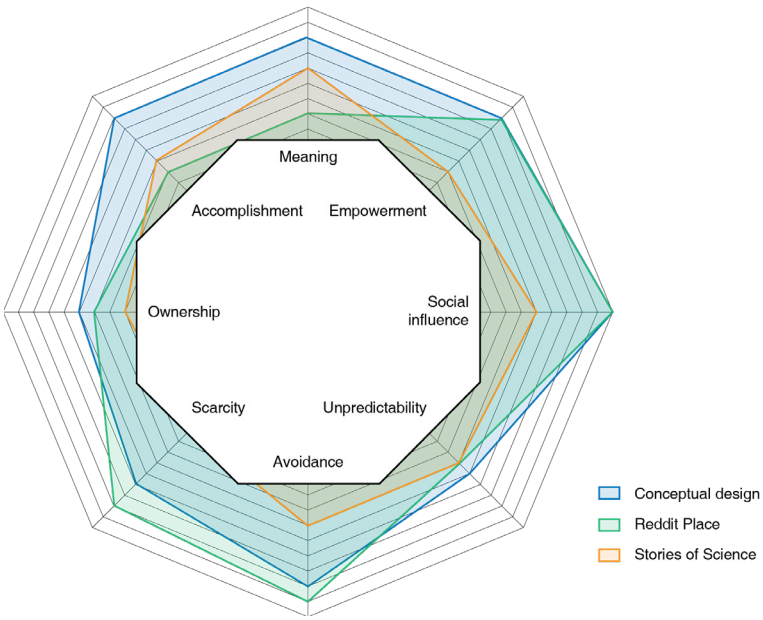


Figure 15 - *Illustration of the three overlapping frameworks by the author.*

Chapter summary

This chapter translated the predictors of engagement from Chapter 2 into design guidelines within a conceptual design. A literature review within gamification found that internalised extrinsic motivation is an interesting way to translate the response efficacy of the TU Delft researchers' communication efforts through badges, points and leaderboards. Social points and group quests can also motivate users as they seem effective in similar contexts, e.g. idea generation competitions. These gamification elements are related to the *Accomplishment* and the *Social Influence* core drives within the Octalysis framework. Such a framework was then used to analyse the current effectiveness of *Stories of Science* and *r/place*, a gamification experience meant to foster collaboration within a social network, in motivating its users. The analysis proved that *Stories of Science* unbalances intrinsic with extrinsic motivation and misses a sense of urgency, while *r/place* seems effective in motivating its users. These analyses also provided further directives on which core drives and gamification elements to include in the design. By generating scenarios within a morphological chart, the study combined the gamification elements from the literature review, the analyses of *Stories of Science* and *r/place*, from the concept of plotting connection through a graph force model and from personal preference to generate the conceptual design. An evaluation analysis with the

Octalysis shows that the resulting conceptual design proves to be in balance according to the Octalysis analysis tool. Hence, to reply to the second sub-research question, **these guidelines can be drawn from the identified factors, design literature and gamification literature to guide the gamified design to improve TU Delft researchers' willingness to engage in online scientific storytelling through the TU Delft-based storytelling platform:**

1. Within the *Meaning* core drive, the conceptual design implements:
    - Humanity hero, by inspiring collaboration through storytelling;
    - Elitism, by admitting users to a privileged group if they submit story ideas;
    - Free lunch, by inviting users to recommend potential new users to join the platform.
2. Within the *Avoidance* core drive, the conceptual design implements:
    - Rightful heritage, by making users compete to create connections;
    - FOMO punch, by blocking users to access the platform if they do not submit story ideas;
    - Evanescent opportunities, by providing users with time-limited opportunities to gain points.
3. Within the *Empowerment* core drive, the conceptual design implements:
    - Milestone unlock, by getting featured by the platform gives users advantages;
    - Choice perception, by letting users create tag, network or suggest connections;
    - Meaningful choices, as networking and collaboration can be beneficial for TU Delft researchers' career.
4. Within the *Social Influence* core drive, the conceptual design implements:
    - Group quests, by competing with peers among faculties;
    - Tout flags, by displaying badges to other users;
    - Social treasures, as points are shared within the whole faculty;
    - Thank-you economy, as networking and stories are beneficial for many users.
5. Within the *Unpredictability* core drive, the conceptual design implements:
    - Glowing choice, by pointing to tags similar to the ones owned by the user;
    - Rolling rewards, by giving random rewards to invite new users or inactive users.
6. Within the *Scarcity* core drive, the conceptual design

implements:

- Magnetic caps, by limiting some of the actions that a user can perform;
- Torture breaks, by restoring the limited actions after a lockout.
- Appointment dynamics, by giving time-limited challenges.

7. Within the *Ownership* core drive, the conceptual design implements:
   - Collection sets, to represent the different type of response efficacy;
   - Protector quest, by making users care about the faculty and their peers.
8. Within the *Accomplishment* core drive, the conceptual design implements:
   - Badges, by rewarding users when they reach one or more goals;
   - Leaderboards, by making the faculties compete;
   - Points, as forming connections among tags is encouraged by earning points.

The following chapter will translate design guidelines from the conceptual design into the first iteration of the hypothetical design, and evaluate such iteration by experts. The guidelines above will guide the design phase of the theoretical design.

Chapter 4

Design phase & evaluation

Chapter 4 uses the conceptual design to guide the design phase through the Six D's to gamification (Werbach & Hunter, 2015). The design followed the six steps defining the cycle of action, feedback and motivation, and the progression stairs to keep the users motivated during the gamified experience. The resulting hypothetical design asks users to submit story ideas, and at least three tags related to their gamification, to unlock the full functionalities of the platform and register. Upon registration, users compete among faculties form as many connections as possible with researchers owning the same tags within the TU Delft. Leaderboards, groups quests and badges, further provide users with feedback of their impact within the network of the university. From the evaluation with the case owner and a gamification expert, the social component of the gamified experience, the submission forms for stories and the balance between intrinsic and extrinsic motivation seem effective in motivating users to engage in proactive submission of story ideas. For the future developments of this project, both experts suggested implementing more tangible real-life or physical rewards, using a weighted score and substitute punishment mechanics with reminders, to further effectively motivate TU Delft researchers. Besides, the gamification expert further suggested developing a testing plan for each mechanic in the next phase of the project.

This chapter aims at answering the first sub-research question: *how can the proposed hypothetical design effectively engage TU Delft researchers into proactive submission of story ideas according to experts?* As described within Chapter 1, the study of Mora et al. (2017) grades the Six D's to Gamification framework developed by Werbach and Hunter (2015) as the highest-scoring framework within their comparative analysis. The next sub-chapter will follow the Six D's to Gamification to generate the first iteration of a hypothetical design within the design phase.

First iteration

Werbach and Hunter (2015) define six steps to implement gamification effectively within their framework: (i) define business objectives; (ii) delineate target behaviours; (iii) describe players; (iv) devise activity loops; (v) don't forget the fun; (vi) deploy the appropriate tools. In the following sections, each of these steps is discussed in details.

Define business objectives

The current aim of the storytelling platform is promoting internal and external communication of TU Delft researchers' projects and daily struggles. Gamification aims to engage TU Delft researchers in proactively engage in storytelling by pitching story ideas by showing them the inbound effects of public communication of science within the TU Delft. Hence, the gamified design should (i) motivate TU Delft researchers to proactively contact the editorial team to pitch story ideas to co-create storytelling, (ii) showing that their engagement has a response within the university, and (iii) increase collaboration within and outside the TU Delft. The next section will delineate the target behaviours of the design.

Delineate target behaviours

Target behaviours should be concrete, specific, and should promote the previously-defined business objectives, even if the relationship may be indirect (Werbach & Hunter, 2015). According to the inputs from Meijer and the design guidelines from Chapter 3, the target behaviours meant for the gamified storytelling platform are the followings:

1. encourage researchers to submit story ideas and engage in co-creation of storytelling for wide audiences;
2. encourage researchers to nudge peers to perform the same action;
3. encourage the exchange of information among researchers;
4. show users the inbound effects of public communication of science within the TU Delft;
5. be engaged in using the platform and returning to it.

The next section will describe the players to engage by the hypothetical design.

Describe the players

Werbach & Hunter (2015) suggest using the Bartle test (Bartle, 1996), which divides users into Achievers, Socializers, Killers or Explorers, as a model to discriminate and gain a further understanding on the game elements that would suit target groups of users. Nevertheless, other types of subdivisions are possible, such as the groups identified through the Technology Acceptance Model (TAM) in Chapter 2. From the results of the TAM analysis, Response-Efficacy (RE), the highest-scoring variable, is used as the main factor to engage users within the gamified design as it is a robust predictor for Perceived Ease of Use (PEU) and Perceived Usefulness (PU) of the storytelling platform. Every group within the TAM analysis presented a high level of agreement based on their average weighted score, except for new users. In particular, the analysis showed statistically significant differences for PhD students, untrained researchers, unfeatured researchers and current users compared to Scientific staff, trained researchers, featured researchers and new users. Results further proved Intrinsic-Motivation (IM) to be a strong predictor of PEU and PU of the storytelling platform, and the design should prioritize intrinsic motivation over extrinsic motivation given a statistically significant difference. The next section will discuss the activity loops.

Devise activity loops

Werbach & Hunter (2015) illustrate two kinds of cycles in gamified systems: the engagement loops and progression stairs. Engagement loops describe what users do, why they do it, and what the system does in response at a micro-level. The progression stairs instead give a macro perspective on the users' journey. Figure 16 illustrates both cycles.

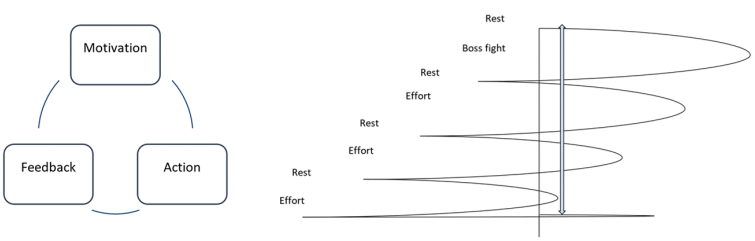


Figure 16 - *Engagement loop (left) and progression stairs (right) (Werbach & Hunter, 2015).*

Within the engagement loop, the idea of **motivation** is that playing the game should engage TU Delft researchers to proactively contact the editorial team, or nudge peers to do so, to engage in co-creation of storytelling. On a second level, the gamified design aims at increasing internal and external communication to benefit TU Delft researchers, e.g. fostering cooperation and innovation, and promote the development of Science (*Meaning* — Humanity hero; Chou, 2015).

When talking about **actions**, researchers need to submit story ideas to unlock the full gamification (Avoidance — Rightful

heritage; Chou, 2015). If potential new users do not submit story ideas related to their research or field of study, along with at least three tags, they can solely visualise the connection among tags, but not the name of the user connected to the tag. By submitting an idea and the tags, TU Delft researchers will unlock the full gamified experience (*Avoidance* — FOMO punch; Chou, 2015), giving access to the group of TU Delft researchers willing to communicate to the public and increase collaboration within the TU Delft (*Meaning* — Elitism; Chou, 2015). After submitting the form, the TU Delft NetID helps with the identification. Registered user can suggest other TU Delft researchers to register to the platform by asking them to select their name during registration. Both get +1 actions per day (*Meaning* — Free lunch; Chou, 2015). Figure 17 shows the flow chart related to the login and registration to the gamified platform.

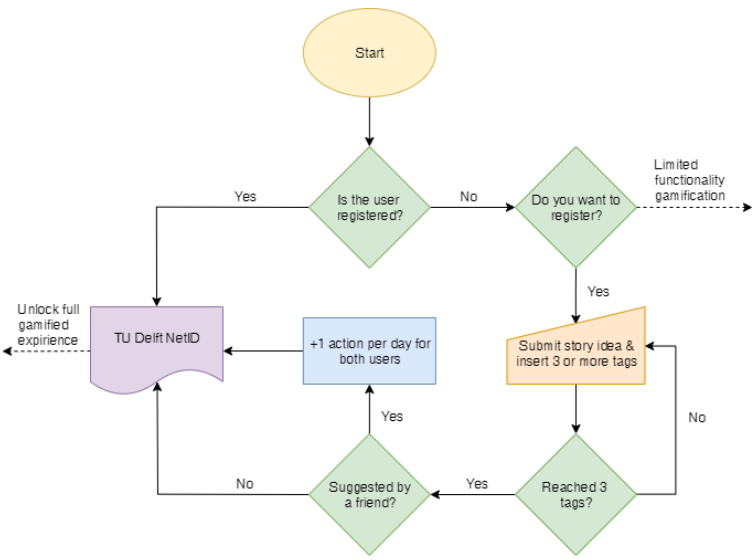


Figure 17 - *Flowchart of the login and registration process by the author.*

Within the gamification, users can perform two types of actions: limited or unlimited actions. Unfeatured users can perform 3 actions max per day, while featured researchers have 3+3 actions per day (*Scarcity* — Magnetic caps; Chou, 2015). Actions are fully restored every 24 hours (*Scarcity* — Torture breaks; Chou, 2015). The limitless actions differ in creating tags, requesting a connection or placing a comment. The limited actions differ in suggesting connections, connecting tags or pulling towards something (*Empowerment* — Meaningful choices; Chou, 2015). Tags can be created from scratch or chosen from a list. In the latter case, the gamification automatically highlights the similar tags within the system (*Unpredictability* — Glowing choice; Chou, 2015). Given the limits of actions, users must compete to connect sooner than other users (*Avoidance* — Evanescent opportunity; Chou, 2015). A tag can be deleted if it has no connections. When spawning in the platform, users are linked

to their faculty and to users of the same department. Connecting with another user's tag, pulls the connected user towards the connector. Faculties do not suffer pulls, and only pulled users suffer misplacement in a specific direction. Each faculty emits a force field based on its score. Users cannot gain points, but whenever they do, the points go their faculty (*Accomplishment* — Points; *Social influence* — Social treasure; Chou, 2015). The higher the score, the wider the energy field. If at the end of the 24 hours lockout one or more user is outside the field, the faculty loses X points based on the amount of users outside of the field. Such mechanics invites users to expand the energy field, or pull other users within to not lose points (*Ownership* — Protector quest; Chou, 2015). Also, connecting tags outside of the force field makes the faculty lose 1 point. Figure 18 summarizes the type of actions performable within the gamified design.

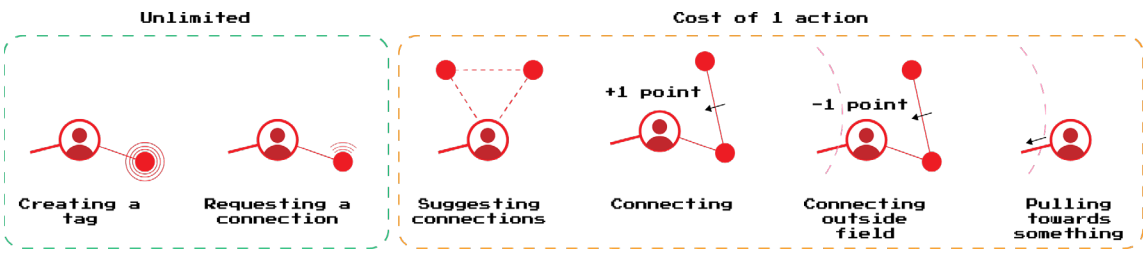


Figure 18 - *Mock-up of the actions that a user can perform.*

Successful connections give +1 points to the faculty, while featured stories give +9 points to the faculty. Suggesting a connection, and having the other users accept such connection, grants both users with +3 points (*Social influence* — Thank-you economy; Chou, 2015) if the connection happens within 72 hours (*Scarcity* — Appointment Dynamics; Chou, 2015). If the user accepts the connection after 72 hours, only the suggester gains 1 point (*Avoidance* — Evanescent opportunity; Chou, 2015). Users can make suggestions that relate to connect to a max of three researchers with one action. If all the researchers accept within 72 hours, all the researchers get N×3 where N is the number of researchers who accepted. Otherwise, the gained points are N×1. The difference in points makes suggesting connections and publishing stories way more appealing than creating connections (*Empowerment* — Choice perception; Chou, 2015). Such a choice nudges TU Delft researchers to maintain and update the network of tags and engage in public communication of science. Besides, every month a small percentage of unregistered researchers are invited to join the platform via email and awarded with +1 action per day if they register (*Unpredictability* — Rolling rewards; Chou, 2015).

Concerning **feedback**, Werbach & Hunter (2015) mention that it should be delivered to the user as soon as an action is performed. Creating tags, connections, making suggestions and pulling force

in a direction can be done immediately, as it is submitting story ideas and subscribing to the platform. The user's progression is represented by publishing stories, making connections and acquiring badges. Every action related to the user is notified to the user through notification within the User Interface (*Social influence* — Tout flags; Chou, 2015). Getting featured on the platform turns users into a Genius (*Social influence* — Tout flags, *Empowerment* — Milestone unlock; Chou, 2015). The genius can either be gold or platinum genius, if the researcher gets published more than once. Badges (*Ownership* — Collection sets, *Accomplishment* — Badges; Chou, 2015) are collected if the user performs one of these tasks:

1. the researcher's story was featured (golden star);
2. the researcher's story was featured more than once (platinum star);
3. the researcher's story was picked up by the media (golden microphone icon);
4. the researcher's story was shared on social media (silver share icon);
5. the researcher has connected with more than 5 users (bronze comic bubble icon);
6. the researcher has connected with more than 20 users (silver comic bubble icon);
7. the researcher has connected with more than 50 users (golden comic bubble icon);
8. the researcher has suggested a connection, and got accepted, 5 times (bronze thumbs-up);
9. the researcher has suggested a connection, and got accepted, 20 times (bronze thumbs-up);
10. the researcher has suggested a connection, and got accepted, 50 times (bronze thumbs-up);
11. the researcher story was viewed more than 100 times (bronze checkmark);
12. the researcher story was viewed more than 500 times (silver checkmark);
13. the researcher story was viewed more than 2000 times (gold checkmark).

Medals from 5 to 13 should be adjusted according to the website traffic, as these numbers may be too difficult or too easy to achieve. Badges pop up by clicking on the user's icon, while the genius star is added next to the user's icon. A flow chart with all the actions and feedback affecting the user is located at page 78 in the appendix.

In regards to the progression stairs, every ten users subscribing makes the faculty gain it gives +1 points (*Social influence* —

Social treasure; Chou, 2015), making the recruitment of new users rewarding (*Social influence* — Group quests; Chou, 2015). A leaderboard shows which faculty is scoring the most points (*Accomplishment* — Leaderboard; Chou, 2015). Monthly challenges should provide special badges, e.g. who has scored the most or published the most in the last month (*Social influence* — Group quests; Chou, 2015). The next section will elaborate on how to make the experience fun for every type of user.

Do not forget the fun

Werbach and Hunter (2015) mention in their book that not everyone will want the same type of fun or that participants can change throughout time. Therefore, to create an effective gamified experience, it is essential to make the experience fun for different groups of users. As mentioned in the "describe the players" paragraph and within the gamification literature in Chapter 3, badges, leaderboards, points and groups quests should strongly motivate all the groups of users described within the Technology Acceptance Model (TAM) analysis — specifically PhD students, untrained researchers, unfeatured researchers and registered users over the other groups. Although response efficacy may not impact new users as the other groups, the gamified design presents several gamification elements that can attract different types of users. On top of that, there are going to be specific challenges available per faculty or department, e.g. connecting as many tags as possible or submitting story ideas in a precise period (*Social Influence* — Group quests; Chou, 2015), to spark interest within the TU Delft. In addition, according to the Bartle player types (Bartle, 1996), the possibility to meet other users can attract Socializers (*Social Influence* — Group quests; Chou, 2015), the badges can attract Achievers (*Accomplishment* — Badges; Chou, 2015), the leaderboard can attract Killers (*Accomplishment* — Leaderboard; Chou, 2015), and the idea of forming a network of researchers can attract Explorers (*Empowerment* — Meaningful choices; Chou, 2015). The next section will focus on deploying the gamified experience and test it.

Deploy the appropriate tools

Within this part, the gamification elements and functionalities are deployed within the gamified system and then tested. The next figures show some mock-ups of the hypothetical gamified design. Figure 19 presents a mock-up of a possible view of the platform when a user creates a connection with another tag from a researcher of a different faculty. Creating a connection gives +1 point to the faculty, and, by clicking on the user's icon, it is possible to gather information and follow the link to his/her page and, most importantly, to his/her stories. Figure 20 instead shows the possibility of visualizing the connections among all the selected tags within the different users and faculties for unregistered users. The call-to-action button, the locked

functionalities and the quick submission of a story help new users register and access the functionalities of the platform with ease. Figure 21 displays the text-area and input areas within the submission form to register to the platform. Users are requested to insert three or more tags to start their story. In this case, they can either create a tag or select it from a list. Upon submission of the form, by clicking “Join”, the NetID takes care of identifying the user.

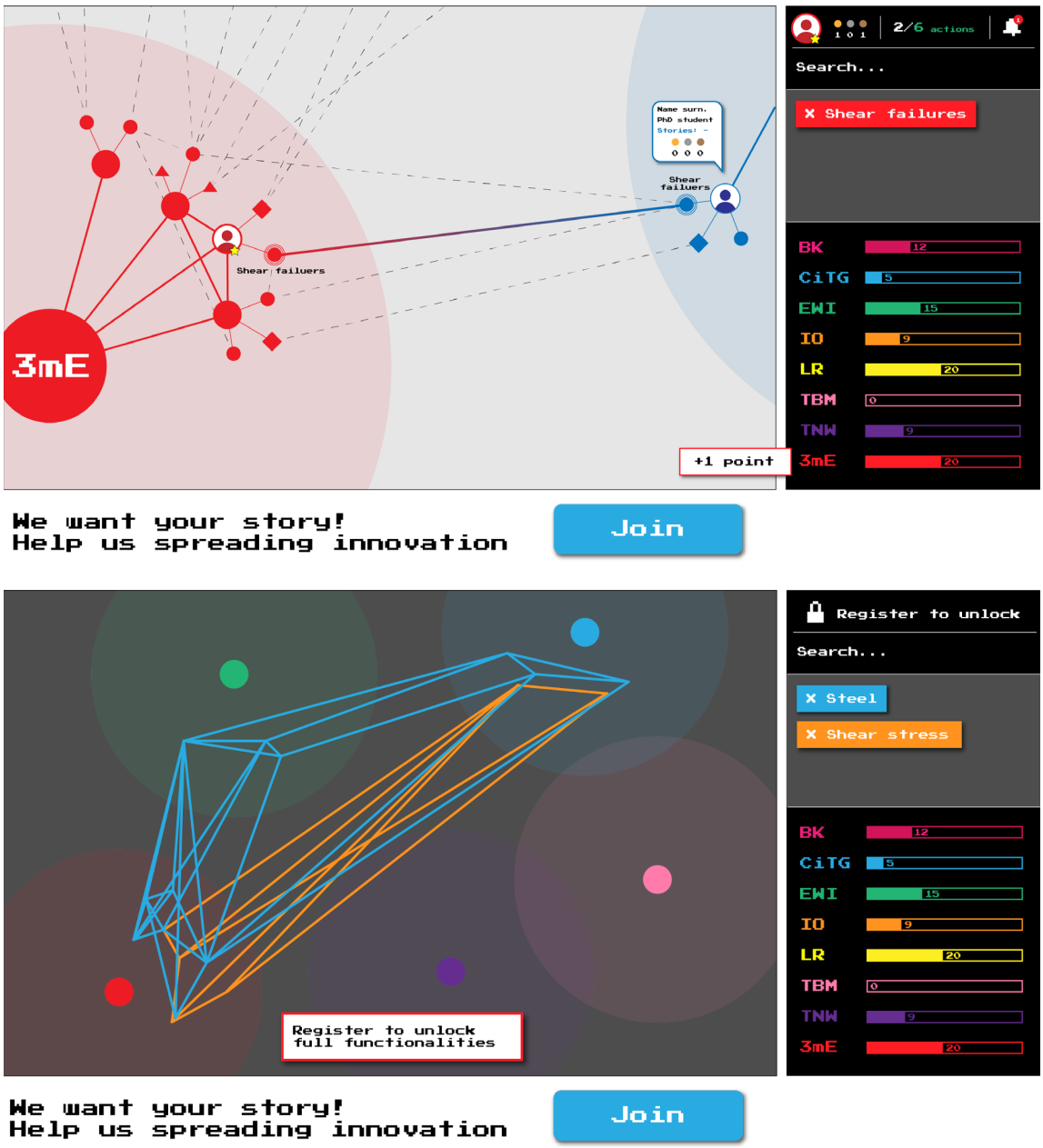


Figure 19 & 20 - *Mock-up of the gamification (top) & mock-up tag-mining system (bottom).*

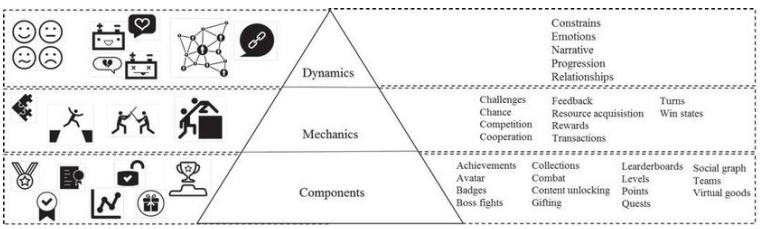
Figure 21 - *Mock-up of the registration form.*

The next sub-chapter, will push further this section by evaluating the first iteration of the design through the Six D's to gamification (Werbach & Hunter, 2015) to later evaluate the design with the case owner and a gamification expert.

Evaluation

To evaluate the first iteration, Werbach and Hunter (2015) suggest using the Pyramid of Gamification Elements. There are three categories of game elements that are relevant to gamification: dynamics, mechanics, and components. Each mechanic is tied to one or more dynamics, and each component is tied to one or more higher-level elements as shown in Figure 22.

Figure 22 - *Pyramid of Gamification Elements (Werbach & Hunter, 2015).*



The gamification implements the following dynamics as shown within Table 12. The table shows that dynamics, mechanics and components within Werbach and Hunter's (2015) Pyramid of Gamification Elements are widely covered within the pyramid of gamification.

Dyanmis	Mechanics	Components
Constraints	Challenge	Content unlocking
	Turns	Achievements, Points
Relationship	Challenges	Achievements, Badges, Points
	Competition	Badges, Leaderboards
	Cooperation	Badges, Collection, Quests, Teams
	Feedback	Achievements, Badges, Collections, Content unlocking, Leaderboard, Points
	Rewards	Badges, Collections, Content unlocking, Leaderboards, Points
Progression	Feedback	Achievements, Badges, Collections, Points
	Rewards	Badges, Collections, Content unlocking, Leaderboards, Points
Relationships	Cooperation	Teams

Table 12 - *Pyramid of gamification elements of the current hypothetical design*

To assess whether users perceive these elements, the next sections will evaluate the first iteration of the hypothetical design through semi-structured interviews with the case owner of the storytelling platform, Roy Meijer, and Gerben Bakker, a gamification expert and PhD student within the Science Communication and Education department, to gather their feedback, questions, remarks or suggestions for future improvements.

Evaluation by the case owner

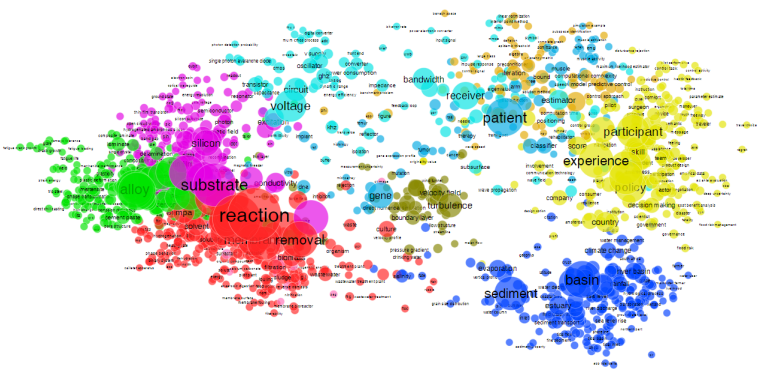
According to Meijer, the pros of this platform is that it makes TU Delft researchers think about their own stories and actively form connections within the university, promoting collaborations and coincidental meetings. He enjoyed the idea that the graph is not static, but alive and dynamic, and users can actively influence it. In his words, the massive plus of the platform is showing the inbound impact of science communication within the TU Delft through a network. He appreciated the tag-mining system to search and add tags since suggestion and the continuous improvements by TU Delft researchers reduce the need for external administration. He also appreciated the tagging system as the idea of the storytelling platform launching soon is based on themes to combine stories in collections. These ideas can nudge researchers to look for connections inside and outside of their network actively.

Meijer expressed his concern questioning whether there are enough incentives for the users to stay active within the gamified design, as well as the potential time-demanding tasks to moderate the platform. The backend system may be able to moderate the system, but it depends on the future iterations of the design. While some faculties may need story ideas, some others are experiencing an oversupply of story ideas, struggling to find time and fundings to write all of them and forcing communication departments to make strategic decisions on

which story to publish, and have some researchers potentially wait long before their story gets featured. He appreciates the idea of the groups' quests, but he questions if the game rewards are important enough for the TU Delft researchers to spend time on the platform, compared to potential real-life rewards like funding applications. He also expressed concerns in terms of the first population of the game, but, in response, it was mentioned to him that by giving automatic access to the TU Delft researchers that already published a story, along with automatically creating tags for their story, can solve this issue.

In the overall, Meijer was satisfied with the gamified design. It raises some interesting points, such as how to communicate the impact of storytelling to the scientists. He further mentioned that the tag-mining system could be connected to the publication database within the TU Delft library, as they have an internal system that automatically extracts tags from papers called AIDA. Figure 23 shows the graph plotted within the "Automatic Identification of Research Trends project" (http://aida.tudelft.nl/).

Figure 23 - *Screenshot of the AIDA project.*



For future developments, Meijer mentioned that it would be interesting to talk with the Information specialist behind the AIDA project and understand the logic of the algorithm behind such software.

Evaluation by a gamification expert

PhD Student Gerben Bakker had some remarks during the evaluation of the design. The first concerned the leaderboard. Since some faculties have more researchers than others or fewer stories to publish, users may perceive the gamified design as unfair. Nevertheless, a weighted score, e.g. based on the number of researchers per faculty, could help to balance the experience. Furthermore, Bakker commented that the White Hat seems vulnerable to the Black Hat due to the punishment part. Punishing individuals for the results of a collective, i.e. the faculty, may produce the opposing effect and become a barrier

for users. Within Black Hat core drive, a simple reminder may work better than the currently proposed system (e.g. “We have not seen you since a while. This is what you have missed”), which mostly influence the FOMO punch mechanic within the Avoidance core drive (Chou, 2015). As also Meijer commented, the lack of physical rewards may have a risk of losing users. By sending some diplomas or prices that value the researchers’ effort in Science Communication, it may further motivate users. In general, he concluded, including more positive mechanics and giving physical rewards can thoroughly benefit the system.

On the other side, Bakker mentioned that he was impressed by how the theories were applied to design the gamified design, as the underpinning from the model was very strong, and that the idea of submitting stories seems very powerful. What the gamified design seems to excel into is the social component within the Social Influence core drive (Chou, 2015). Bakker liked the idea of the network and being visible within the university as someone that cares about collaboration and innovation. He mentioned to have personally encountered problems networking with TU Delft researchers within the same field, and such a solution would have saved him time and effort.

The system looks both complex and complete, but to sufficiently test its effectiveness, the next phase should aim at prototyping each mechanic with a sample of users. The plan should include a specific number of questions, and each iteration should answer one of these questions in regards to an assumption made during the design. Such reason is related to the Mechanics Development Aesthetics (MDA) model (Hunicke et al., 2004), from which Werbach and Hunter (2015) derived their Pyramid of Gamification Elements. According to the MDA, from the perspective of the designer, the mechanics generate dynamics which generate aesthetics. The perspective of the users is the other way around, who perceive first the aesthetics, then dynamics and, finally, the mechanics. This relationship poses a challenge for game designers as they are only able to influence the mechanics to produce meaningful dynamics and aesthetics for the users. Therefore, it is critical to test the intended mechanics and verify if they have the desired effect on the users. The following paragraph will elaborate on the conclusions of this chapter.

Chapter summary

This chapter used the guidelines from Chapter 3 to generate a hypothetical design for the gamified storytelling platform and evaluate it with experts to assess its effectiveness. The Six D's to gamification helped the study to turn the design guidelines into gamification elements and deploy them, turning them into a mock-up of the first visualised design. After a self-evaluation of the design with the Pyramid of Gamification Elements, the case owner of the storytelling platform, Roy Meijer, and a gamification expert, PhD student Gerben Bakker, evaluated the design. They highlighted which parts of the design seem capable of motivating TU Delft researchers and which instead may need improvements in future iterations. This study is not going to modify the design based on their inputs, but it will discuss them within the next chapters and the future development of the project. Hence, to reply to the third sub-research question, **according to experts, the proposed hypothetical design effectively engage TU Delft researchers into proactive submission of story ideas by:**

1. showing researchers the social advantage of submitting story ideas to engage in co-creation of storytelling within the TU Delft, according to both Meijer and Bakker;
2. encouraging TU Delft researchers to submit story ideas, according to Bakker;
3. implementing intrinsic motivation and balancing it out with extrinsic motivation, according to Bakker.

The following chapter will discuss the findings of this research project, along with what they add to the existing theories.

Chapter 5

Discussion

Chapter 5 discusses the findings of this graduation project, commenting on what they add to the current theories. The response of an engagement outside and within the TU Delft seem to have a stronger relevance over intrinsic motivation and the other variables. Future studies on this matter can provide science communicators with further insights on the impacts of engagement within scientific institutions. Such impact varies from possible collaboration to understanding if scientists' reputation could be at stake after the communication effort. Besides, the first iteration of the hypothetical design shows that reducing time-demanding tasks, and showing the benefits it could have on their network, can nudge TU Delft researchers to submit story ideas and engage in proactive media contact. The future development of this graduation project should focus on implementing the feedback from the evaluation session and on testing each mechanic to verify the assumptions of this graduation project. The iterative tests should focus on one mechanic per test, and either modify the experience or test the next mechanic in the next iteration. Tests should involve different groups identified within the study and from different TU Delft faculties as well, and, scale up the gamified design within different scientific organisations.

In Chapter 2, the literature review found out that age, scientific status, perceived norms, response efficacy, self-efficacy, intrinsic motivation and extrinsic motivation (Besley et al., 2018; Besley et al., 2019; Entradas et al., 2019), are significant predictors of scientists' willingness to engage in public communication of science. In the specific context of online storytelling, Besley et al. (2018) mention that younger and less experienced scientists seem to privilege the use of online engagement, compared to older and more experienced scientists. These findings were assessed in the following chapter by analysing which factors can positively impact TU Delft researchers' attitude towards TU Delft based online storytelling platforms. By interviewing a sample of TU Delft researchers (N = 31) through a Likert-scale type questionnaire (Likert, 1932) over their attitude towards an existing online storytelling platform, the findings confirmed the study of Besley et al. (2018) since PhD students scored the highest on Response-Efficacy (RE), Perceived Usefulness (PU), Attitude towards Use (AU) and Behavioural Intention (BI) over the Scientific staff. Featured researchers also scored the highest in Intrinsic Motivation (IM) and Perceived Ease of Use (PEU). Such findings are consistent with Besley et al. (2018), who mentions that past quality of experience is a strong predictor of willingness to engage, and Entradas et al. (2019), who mention the importance of intrinsic motivation versus extrinsic motivation in engaging scientists to engage in public communication of science. Response-Efficacy (RE) and Intrinsic motivation (IM) proved to be respectively the first and second-highest scoring variable within the TAM analysis and to be reliable through their Cronbach's alpha ($\alpha > .60$) (Cronbach, 1951). The value of Response-Efficacy (RE) within science communication is consistent with Besley et al. (2018), who mention that tracking the engagement impact is a strong predictor of engagement with the public. This finding further adds to existing theories that, while the quality of the experience plays a role in motivating scientists, science communicators should prioritise tracking the impact of scientists' communication efforts through measurable data as scientists seem to value mostly that their efforts in public communication of science have a positive impact within and outside of their institution. Tracking such efforts through measurable data should also provide scientists with further insights on the norms within the scientific institution, as Besley et al. (2019) mention the importance of assessing the ethics of the communication before engagement. This factor suggests that future studies should strengthen the findings of this research project by investigating if measuring the efforts in public communication of science within scientific institutions through measurable data, enables scientists communicators to understand further whether engaging in science communication may lead

scientists to informal peer-based sanctions despite potential contrasting claims from the scientific institution.

In Chapter 3, the study focused on translating the Response-Efficacy (RE) predictor of engagement into a design guideline, and design the gamification by preferring intrinsic motivation over extrinsic motivation. Through a literature review within gamification, both Scheiner (2015) and Mekler et al. (2017) agreed that the gamification elements within the *Accomplishment* core drive (Chou, 2015), i.e. badges, leaderboard and points, seem best in increasing users' internalised extrinsic motivation. Since Besley et al. (2018) mention that response efficacy is bound to a reward, future studies should continue to investigate whether badges, leaderboards and points are effective in tracking the engagement impact and motivating scientists to engage in public communication of science. In addition, gamification elements from the *Social Influence* and *Empowerment* core drives (Chou, 2015) proved to be effective in motivating users to cooperate and generate idea, as both r/place is heavily focused on them and Scheiner (2015) mentions the importance of social points and exchange, i.e. providing users with meaningful actions, when gamifying idea generation competition. From these findings, future studies should investigate if social points are also effective to motivate scientists into public communication of science and into proactive media contact within gamified experience.

In Chapter 4, the study focused on using the design guidelines from Chapter 3 to turn them into a hypothetical gamified design through the Six D's to gamification, and evaluate the first iteration by experts. Through two semi-structured interviews, the case owner, Roy Meijer, and a gamification expert, PhD student Gerben Bakker, evaluated the design. They both appreciated the social influence component of the platform, showing that indeed tracking the engagement impact of communication is indeed a strong predictor of motivating scientists to engage public communication of science as mentioned by Besley et al. (2018). The online submission, praised by Bakker, seems to be an effective tool to motivate scientists in submitting story ideas, as it is a content to unlock the full functionalities of the platform and gain something that may benefit the scientist's career (Werbach & Hunter, 2015) through an online form that reduces time-demanding tasks (Besley et al., 2018). Such findings strengthen the existing theories that reducing time-demanding tasks can engage scientists to engage in public communication of science, and should further direct their efforts in assessing if it works as well for proactive media contact. The next session will discuss the limitations of this research project.

Limitations

The time-frame of this project was of 375 hours (15 ECTS), which restrained the outcome to a theoretical design. A working prototype would have allowed, through the second round of interviews with the TU Delft researchers, to understand further the effectiveness of the first iteration of the gamified design in motivating its users. The analysis of the effectiveness of *Stories of Science*, *r/place* and the proposed design to motivate its users, was carried out with the tool available on Chou's (2015) website (http://www.yukaichou.com/octalysis-tool/).

The scoring system of such a tool is not empirical, but is based on subjective judgement and experience with the platform. The second round of testing could have verified these assumptions as well. Parantion, the software used for the Likert-type scale questionnaire, has a limit of 500 respondents for students. This issue reduced the number of respondents who replied to the entire questionnaire during the design of the gamification (31 out of 500), obtaining a 3.7 % of total valid responses out of 828 total TU Delft researchers from the Civil Engineering & Geoscience (CE&G) faculty. Such a sample is insufficient to satisfy the requirements of representativeness. Furthermore, the TU Delft website is not fully up-to-date because some emails were rejected as some researchers are not anymore on contract with the TU Delft. This factor hampered the possibility to send the questionnaire to researchers who were more likely to reply. The gamified design was based on the researchers' responses of the CE&G faculty, as they already know and use a storytelling platform. This may imply that the gamified solution may be ineffective for the other researchers within the seven remaining TU Delft faculties. An evaluation phase with a sample of TU Delft researchers from a different faculty would have helped to test further which design elements would be effective to implement on the platform, and if the design, as a whole or in its part, accomplishes its premises.

Future developments

The future development of the gamified platform should focus on developing the second iteration of the hypothetical design to adjust the design according to Meijer and Bakker's inputs. Such adjustments should focus on:

1. offering more appealing physical or real-life rewards, according to both Meijer and Bakker, as Werbach and Hunter (2015), who mention the potential of using physical rewards, e.g. a printable diploma, within businesses to motivate employees;
2. substituting the subtraction of points with more positive mechanics, e.g. reminders, to motivate TU Delft researchers to return to the platform, as mentioned by Bakker;

3. weighting the score due to different amount of researchers per faculty or oversupplies of story ideas, according to both Meijer and Bakker.

Upon completing the second iteration of the hypothetical design, to test if the system effectively engages its users, Deterding (2014) suggests engaging in iterative experiential prototyping until the total prototyped socio-technical system affords the targeted motivational experiences. Future developments of this project should focus on designing a minimal viable product to test each specific mechanic on a sample of TU Delft researchers, e.g. from a different faculty or per group identified within Chapter 3, using the Pyramid of Gamification Elements (Hunicke et al., 2004; Werbach & Hunter, 2015) as a guideline, and evaluating their attitude towards each mechanic with the Hedonic motivation system adoption model (HMSAM) (Lowry et al., 2013; Werbach & Hunter, 2015). The results should indicate whether the mechanic confirms the assumptions proposed during the design, or the mechanic needs improvements to reach such a result. In the latter case, the mechanic should be re-designed and tested in the next iteration, until the intended results are reached. When each mechanic has been tested, it would be interesting to develop a fully working prototype of the gamified experience and deploy it on the storytelling platform, to see the potential improvements on the website traffic and amount of proactive media contact by TU Delft researchers. If the platform results to indeed increase traffic and proactive contacts, it would be interesting to optimize the proposed gamified design within the TU Delft, or test it outside of the TU Delft, e.g. within a different university or scientific institution. Such data should further indicate which design elements are effective and which need re-adjustments in case this gamified design is scaled up to target different users or implement different motivational experiences. The next chapter will draw the conclusions of this research project.

Chapter 6

Conclusion

Chapter 6 discusses the conclusion of this graduation project. Rewarding TU Delft researchers who proactively requests to engage in co-creation of scientific storytelling, with measurable data of their inbound and outbound impacts in communication, seems effective in motivating TU Delft researchers. Achievements and reducing time-demanding tasks also proved to have a role in motivating TU Delft researchers. Future research in Science Communication should further investigate the effects of tracking the engagement efforts in communication, to study the effects of science communication and proactive media contact on collaboration and scientists' reputations. The acknowledgements paragraph shows my gratitude to all the individuals that helped throughout this graduation project.

Gamification seems to engage TU Delft researchers into proactive submission of story ideas for a non-profit scientific storytelling platform for wide audiences, by showing the inbound effects of TU Delft researchers' engagement within the TU Delft of encouraging networking and collaboration, and by facilitating the submission reducing time-demanding tasks.

Despite public communication of science is seen as important within universities and scientific organisations, proactive media contact can still not be well seen within the scientific community, and it may lead to informal peer-based sanctions. The study first analysed which predictors of engagement can be used to increase TU Delft researchers' interest to engage in public communication of science through online storytelling, to verify whether gamification can motivate TU Delft researchers to act differently. The study assessed a sample of TU Delft researchers through the Technology Acceptance Model (TAM), and response efficacy and, on a second level, intrinsic motivation proved to be strong predictors of perceived ease of use and perceived usefulness of *Stories of Science*, a storytelling platform similar to the one in development.

Through a literature review within gamification and an analysis of case studies with the Octalysis framework, *Stories of Science* and *r/place*, the study investigated which gamification elements can best translate response efficacy and intrinsic motivation as design guidelines. Leaderboard, badges and social points proved to be the most effective gamification elements to represent response efficacy within the TU Delft, as they affect internalised extrinsic motivation. Such findings were translated within a morphological chart to generate different scenarios to combine the inputs from the case studies, from the idea of representing response efficacy through connections within the university, and to achieve a balance between intrinsic and extrinsic motivation, to define the design guidelines. The design guidelines implemented gamification elements from each of the Octalysis core drives, with a special interest for the *Accomplishment* and the *Social influence* core drive.

The study followed up by using the Six D's to gamification to translate the design guidelines into the first iteration of the first hypothetical design. The result is a gamified experience that rewards TU Delft researchers' submission of stories with the possibility to participate in the co-creation of a network that can foster collaboration and innovation. According to an evaluation with the case owner and a gamification expert, the gamified experience seems to be effective in engaging researchers to submit story ideas by the idea of increasing their network of

collaboration, through a system that encourages ideas submission, and by balancing both intrinsic and extrinsic motives to attract differently motivated researchers.

These findings show that if science communication has a measurable impact within the TU Delft, e.g. by benefitting the researchers' career, and reduces time-demanding tasks, proactive media contact can be welcomed by TU Delft researchers and not be subject to informal peer-based sanctions. Encouraging scientists to engage in science communication by showing their efforts in communication with the public through measurable data within and outside universities, should be considered by future studies that wish to increase cooperation within scientific institution and reduce informal peer-based sanctions.

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Appendix

TAM questionnaire sample

Thank you for agreeing to take part in this important survey measuring your attitude towards communicating science to the public through storytelling. This survey should take around 10 minutes to complete. Your participation is voluntary and all of your responses are anonymous. None of the responses will be connected to identifying information. Click below to agree and start the survey.

1. I agree with the above conditions (if 'No', end the questionnaire).
2. Is it the first time you hear about 'Stories of Science'? (if 'Yes', jump to question 6)
3. Did you ever get published on Stories of Science?
4. What are you using the platform for?
5. How frequently do you visit the platform?
   - Daily
   - Weekly
   - Monthly
   - Yearly
6. What is your position within the TU Delft CE&G faculty?
   - PhD student
   - Scientific staff (Postdoc, Researcher or Professor)
   - Guest Research / Teachers
   - Other

Perceived-Norms (PN)

1. I am willing to publish my research through 'Stories of Science' because my colleagues do so.
2. I am willing to publish my research through 'Stories of Science' because the TU Delft promotes it.
3. My colleagues would be positive about me and my research getting published on 'Stories of Science'.

Self-Efficacy (SE)

1. I consider myself competent in interacting with the editorial team of 'Stories of Science' and let them write a story about my research.
2. I consider my work difficult to explain to non-experts and feature it on 'Stories of Science'.
3. Did you receive Media training or Communication training

at the TU Delft or in a different university? (if 'No', jump to question SE4)
    - I consider the Media training or Communication training to have increased my effectiveness in interacting with e.g. the editorial team of 'Stories of Science'.
4. Time pressure hampers my willingness to communicate science to non-experts through 'Stories of Science'.
5. My academic productivity (e.g. number of publications, h-index) gives me confidence in being published on 'Stories of Science'.

Intrinsic-Motivation (IM)
I prioritize fun over potential rewards when communicating science to non-experts.
I prioritize fun over potential rewards when reading stories on 'Stories of Science'.

Extrinsic-Motivation (EM)
1. TU Delft policies motivate me to communicate science to non-experts via 'Stories of Science'.
2. My role as a researcher motivates me to communicate science to non-experts via 'Stories of Science'.
3. The coverage of my research topic in the media enhances me to communicate science to non-experts via 'Stories of Science'.

Response-Efficacy (RE)
1. I consider my topic of research relevant to the public.
2. I consider my topic of research relevant to 'Stories of Science'.
3. (*If you never got published on 'Stories of Science', mark 'NA'*) I consider my efforts in communicating science to non-experts through 'Stories of Science' to have a positive impact on the public.
4. I consider engaging in the communication of science to non-experts via 'Stories of Science' important for my research.

Perceived Ease of Use (PEU)
1. I find the 'Stories of Science' platform easy to use.
2. I find the 'Stories of Science' platform easy to find.
3. I think finding what I want (e.g. stories similar to my research), via 'Stories of Science' is easy.
4. I find the 'Stories of Science' platform attractive.
5. I find the stories on 'Stories of Science' attractive.

Perceived Usefulness (PU)
1. I find the 'Stories of Science' platform appropriate for external communication towards the public.

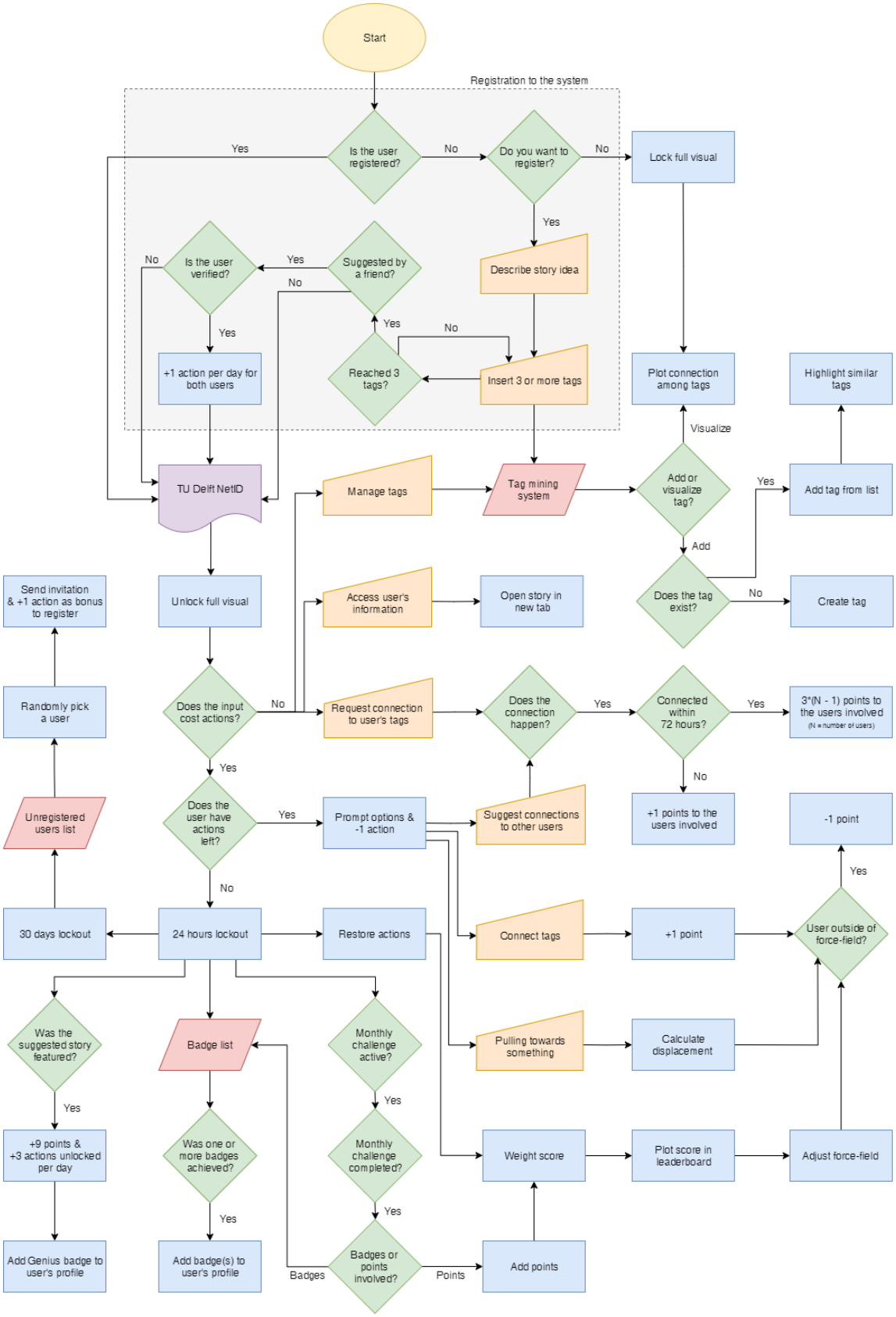
2. I find the ‘Stories of Science’ platform appropriate for internal communication within the TU Delft.
3. I believe that communicating science through ‘Stories of Science’ platform will enhance my effectiveness in communicating science to non-experts.
4. I believe that doing Science Communication through ‘Stories of Science’ will enhance my performance as a researcher.

Attitude towards Use (AU)

1. Publishing stories about my research in ‘Stories of Science’ is a good idea.
2. Publishing stories about my research or projects in ‘Stories of Science’ generates a positive answer.
3. I am positive towards ‘Stories of Science’.

Behavioural Intention (BI)

1. I intend to check frequently new stories on ‘Stories of Science’.
2. I intend to recommend ‘Stories of Science’ to my colleagues.
3. I intend to contact ‘Stories of Science’ if I have an interesting research topic or project to communicate.
4. I intend to recommend my colleagues with an interesting research topic or project to contact ‘Stories of Science’.


Start
Registration to the system
Is the user registered?
Yes
No
Do you want to register?
No
Lock full visual
Yes
Describe story idea
Suggested by a friend?
Yes
No
Is the user verified?
No
Yes
+1 action per day for both users
Yes
Reached 3 tags?
Yes
No
Insert 3 or more tags
Plot connection among tags
Visualize
Highlight similar tags
TU Delft NetID
Manage tags
Tag mining system
Add or visualize tag?
Yes
Add tag from list
Add
Send invitation & +1 action as bonus to register
Unlock full visual
Access user's information
Open story in new tab
Does the tag exist?
No
Create tag
Randomly pick a user
Does the input cost actions?
No
Request connection to user's tags
Does the connection happen?
Yes
Connected within 72 hours?
Yes
3*(N - 1) points to the users involved
(N = number of users)
Yes
No
Unregistered users list
Does the user have actions left?
Yes
Prompt options & -1 action
Suggest connections to other users
+1 points to the users involved
-1 point
No
Yes
30 days lockout
24 hours lockout
Restore actions
Connect tags
+1 point
User outside of force-field?
Was the suggested story featured?
Badge list
Monthly challenge active?
Pulling towards something
Calculate displacement
Yes
+9 points & +3 actions unlocked per day
Was one or more badges achieved?
Monthly challenge completed?
Weight score
Plot score in leaderboard
Adjust force-field
Yes
Yes
Yes
Add Genius badge to user's profile
Add badge(s) to user's profile
Badges or points involved?
Badges
Points
Add points

This research project proposes a theoretical gamified design of a storytelling platform to engage TU Delft researchers into proactive submission of story ideas to co-create online storytelling for wide audiences. While universities have focused on improving communication with the general public in the past decades, researchers may still find barriers to engage in public communication of science. One of these barriers is proactive media contact, as the scientific community may perceive it as outside of the researchers' role and subject the "transgressor" to informal peer-based sanctions. By assessing a sample of TU Delft researchers' attitude towards an online TU Delft non-profit storytelling platform for internal and external communication similar to the target one, response efficacy proved to be the primary variable to motivate TU Delft researchers to engage in co-creation of online storytelling. The findings further confirm existing theories that younger and more intrinsically motivated researchers seem more willing to engage in online storytelling compared to older and more extrinsically motivated peers. The study translated these guidelines into a gamified design based on graph force models that challenge researchers to create tags related to their story, and form connections with peers within the TU Delft. To access these functionalities, TU Delft researchers must register to the platform by submitting a story idea, e.g. related to their researcher or field of study, and be willing to co-create online storytelling if their story is chosen. The design targets different groups of users by balancing the experience through the Octalysis framework, and implementing social points, competitions among faculties and badges. According to an evaluation with the case owner and a gamification expert of the first iteration of the design, rewarding the submission of stories with a network, seem effective in engaging TU Delft researchers to submit story ideas proactively and enhance collaboration and innovation with the TU Delft.