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EXPLICATION AS A DRIVER IN INNOVATION AND ENTREPRENEURSHIP

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***Keywords**: Design process, explication, effectuation, engineering curriculum design, innovation education.*

ABSTRACT

This paper presents a cross-course design and the underlying model and explains how we use explication of knowledge (Nonaka 1996) as a core element in both courses. The purpose of the courses is to foster entrepreneurship among engineering students at the Technical University of Denmark.

For five years, the authors have run the two courses 'Green Entrepreneurship' and 'Prototype Development' in close collaboration and prepared the students for the internal university competition Green Challenge. Industry representatives, politicians, researchers and students judge the challenge. From 2015 to 2019, our students had eleven out of twenty-one possible top three rankings in the competition.

Whereas the two courses present the students to various theoretical concepts, they both facilitate the students to iterate in multiple loops, investigating the context, gaining knowledge, (re-) defining the problem, explicating proposals to an audience and retrieving feedback.

We argue that one single factor why the students do well in the Green Challenge is the recurring explication where the students express their emerging understanding (Lawson 2005) of the problem in recurring pitch situations. For each new explication in the course, the students become more accurate in their communication, more conscious about the context, and reach a new level of understanding of the problem, as a solution emerges.

The data behind this paper is student material presented throughout the two courses, the student's final reports and the competition results.

The paper is a conceptual paper that proposes a design for an entrepreneurial course with the recurring explications as the driver.

1 INTRODUCTION

1.1 Preface: The situation of explication

In a few days I will be responsible for an event, scheduled for a while and entitled *"Workshop with the hospital"*. It is related to a new innovation project with the aim of *"Empowering the Innovation Ecology at the Hospital".* At the event, the project group will pitch the core of the project to the management of a potential partner organization, hopefully to obtain their support. When the project group last met a month ago, a number of to-do's and important questions were articulated and delegated. Since, reflection has taken place but everyday-business has occupied most of the calendar. Now the advancing deadline triggers action. Energy rises. Mails are sent. Telephone and Skype calls take place. Agenda, project proposals and slides are drafted, circulated and refined. Difficult decisions are suddenly made swiftly. At the upcoming event a project proposal finished in the last minute of the 11th hour will be explicated, expressing our most present understanding of what we are up to. The minute before the event we will probably have a common belief of what problem the project is about to solve and how to solve it. But likewise probably, the minute after the presentation, when we have sensed the mood of the room and got the response from the audience, our priorities are no longer that certain. Our basic assumptions might have side stepped a little. New aspects are brought into consideration and aspects we previously considered to be inferior are now in focus. The actual *matter of concern* has been subject for a *translation* [1] and *pivoting* [2] has taken place. Consequently, new domains of knowledge must be investigated. New experiments must be conducted. A number of to-do's and important questions are articulated and delegated. New events will be set…

Most project-workers and entrepreneurs are familiar with these endless loops of *situations of explication* with the derived translations and incremental steps forward. With the current paper we present and discuss a course design building on the hypothesis that these situations are not only a frustrating necessary evil, neither a moment of make or break, as claimed in popular TV shows like the Dragon's Den, but rather a chain of powerful situations where learning are gained and the innovation gradually *comes into being*.

1.2 The courses and the Green Challenge competition

In the present paper we take a look at the five ECTS course *62024 Prototype Development* (PD) [11] offered at DTU-Diploma, Copenhagen Denmark. PD is offered in the end of the academic year at second semester of the first year at the studyprogram Process and Innovation. To the students, PD is experienced as an extension of the five ECTS course *62014 Green Entrepreneurship* (GE) [12], offered earlier in the second semester. The students' work with the same project throughout both courses with the end goal of participating in the DTU Green Challenge (GC). GC is an open contest where more than 100 student-projects with elements of sustainability are evaluated and rated against four parameters by boards with

participation of industry experts, politicians, students and scholars. The top three projects in four academic categories are rewarded.

The two courses have been carried out in their present form since 2015. In the period our students have won eleven out of twenty-one possible top three rankings in the GC. In 2019, 30 projects participated in our category and we had seven out of our nine groups in top ten.

The courses embrace the significance of the situation of explication. In particular in the PD course a series of explications named *pitches* is the backbone of the course design.

With this paper we follow the chain of explications during the PD course 2019 exemplified by one selected group, hereafter referred to as Foamy by the name of their final product. The group ended up ranking nine in the competition, and as such average when it comes to the competition result. Wether the group is methodological representative will be discussed in the concluding chapter.

2 THEOERETICAL OUTSET

The theoretical justification for the hypothesis rest on organizational theory [5], Actor Network Theory (ANT) [1] and design theory [3,6,7,8,9]

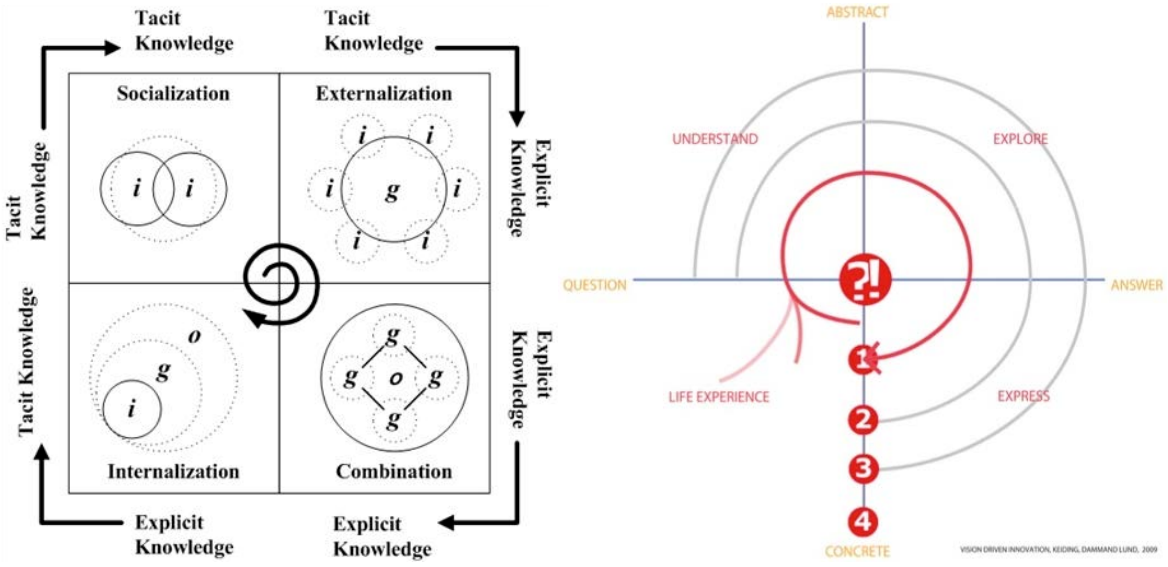
The SECI model (figure 1, left) illustrates the process of organizational knowledge creation where tacit and explicit knowledge is exchanged in a social dynamic. The term *explication* describes the action where tacit knowledge is translated into explicit knowledge and materialized verbally, as text, as prototypes or otherwise.

ANT explains how knowledge emerges while a *matter of concern* is subject to a chain of translations performed by multiple actors, where, in the context of innovation, the outcome is gradually stabilized. The term matter of concern (in contrast to *matter of fact*) states that knowledge is contestable and context dependent. In an innovation context a *matter of concern* describes an opportunity, a case, a problem or a problematic situation [8] serving as the outset for the innovation process. The concept of *chains of translation* is consistent with the concept of the design discourse [9], describing innovation as a process where key interpreters propose a vision to mobilize a network of actors with different perspectives to partake in interpretations that gradually shape and qualify the vision while it is materialized. A hermeneutic practice [6] takes place while problem and solution emerge together [7] The process alters between the core activities of the hermeneutic design process: analysis, synthesis and evaluation, as show in *the brick model*, by Lawson [7].

The VDI model[1] (Fig. 1 right) integrate the perspectives above. The *matter of concern* is the pivot of the process, shown as a unity of a question mark (‘?’ represent the problem) and an exclamation mark (‘!’ represent the proposed vision or solution). Each loop converges [10] into a situation of explication. The chain of

[1] VDI is an agronym for Vision Driven Innovation [3, 10]

situations numbered 1, 2, 3, 4, is shown down the vertical axis. Like Lawson's model, VDI is a hermeneutic design process model, but the phases are named by the narrative *understand, explore, express*, where *express* equals *explication.* The fourth phase; *life experience* (fig. 1 (right): lower left quadrant) represent the response from the world whenever something is spoken out loudly. *It's an ecco*, as we explain it to the students.The progress and ultimately the result of the process depend on the extent to which the key interpreter, that is the student, listens, learns and allows the response to shape the matter of concern at hand, and guide the process.



Figur 1(left): The SECI model [5]. (right): The VDI design process model [3]

2.1 Explication in a course context

Explications take place countless times during a process as the one described in this paper. Some explications are planned and inherent to the course design. This covers pitches and submissions, formel supervision, the exam and the final pitches at GC. Others are performed by the group as various kinds of interaction with stakeholders like expert interviews, user observations, workshops and tests of prototypes, or situated when e. g. group members present new insights to each other, or small talk at a family dinner. Ultimately, all situations can be regarded explications where *a designer,* e.g. a team member, *express* the intention and how to achive it and listen actively to the response, Any explication will articulate a proposal that is also a question, that is; *how do this relate to* your *experience of life?*

3 METHODOLOGY AND EMPIRICAL MATERIAL

This paper focuses on the Prototype Development (PD) course 2019 and the process of one team. Empirical data includes course material, scores and feedback from three PD pitches and the final exam, scores and transcripted video from the final GC pitch, pitch manuscripts and other material handed in during the PD course, and teachers notes from pitches and supervision. See overview in table 1.

The VDI model and the narrative *understand, explore, express* is initially introduced to the students at the PD course.

The primary learning objective for the GE course *is to document a business opportunity in a business plan* [12]. As said, the students continue to work on the same project in the PD course, but to meet the learning objective to *develop a comprehensive prototype [...] as an integral part of an overall project communication* [11]. We put it slightly more straight forward to the students: They should make the business opportunity come into beeing!

3.1 The Prototype Development Course design

The PD course is a five ECTS course offered in a three week period in June. The subject of the course is *the process of prototyping*. It is a challenge based course with 40 students working in nine groups, structured in three *sprints* [13] converging into three *pitches*. The groups work independently and are self organized apart from an introductional day, the pitches and the exam. Supervision is offered throughout the course.

#	Planned by	Date	Situations of explication	Documentation
1	GE course		Half way pitch	
2	The Group		Interviews with healthcare professionals	
3	GE/ GC		GC abstract	Submission
4	GE course		Oral Exam	
5	PD course	0706	Pitch 1	Submission, notes, score
6	The Group		Workshop in the kindergarten	In reflection rapport
7	PD course	1406	Pitch 2	Submission, notes, score
8	The Group		Test in a kindergarten	In reflection rapport
9	PD course	1706	Pitch 3	Submission, notes, score
10	The Group		Presentations to healthcare professionals	In reflection rapport
11	PD course	2206	Reflection rapport	Submission
12	PD course	2306	Exam	Teachers notes
13	GC	2406	GC Pitch	Transcripted video, score

Table 1: Planned situations of explication on a timeline throughout the course and how they are documented. Some are part of the course design, others are initiated by the team. The table will be referred to by the numbers in the left most column.(tab.1 #n). Quotes are translated from Danish by the authors.

The pitches at the course are with some exceptions following the pitch format used in GC. A GC pitch has a duration of two minutes, then it will be stopped. It is followed by five minutes for clarifying questions, whereafter the panel evaluates the pitch compared to four GC parameters[2] and rates the pitch on each parameter on a scale from one to ten. The group will pitch for three panels and a total score is calculated. Likewise the PD pitch has a duration of two minutes. A timekeeper will let the group

[2] Green Challange parameters [4]: On a scale from 1-10…

- Is the project well-structured and clearly communicated?
- To what extend is the positive impact on the UN Sustainable Development goals made probable?
- To what extent is the project technically applicable and likely to be realized?
- To what extent is it visionary and/or innovative?

know when time is up. The pitch is followed by five minutes of questions and feedback from supervisors and five minutes feedback from the class. Finally there will be a voting session and each team and the supervisors rates the pitch following the GC format in a Google form where also written feedback is optional. An average rating is calculated instantly and presented to the group.

To the students we stated that *prototyping is driven by feedback. […] Feedback is about learning, not about right and wrong or whether an idea is good or bad. […] When you receive feedback; • DO NOT RESPOND - you have no time for that, at all. The pitch is about getting the most out of your audience.* (From course document: This is how a pitch goes).

3.2 The Foamy process

The process of Group 7 exemplifies the concept of explication and the narrative of the VDI model. It is the story about the coming into being of *Foamies, some silly little animals living in the sink* (tab 1 #5)

Pitch 1: During the GE course Group 7 *focused on the social gain of more frequently handwash, especially with kids since they are more receptive to behavioral changes* (tab 1 #11). We step into the story at the first PD pitch. Based on dialogue with experts and employers at a kindergarten the group propose that:

…the low rate of people washing hands causes an increased rate of infections transmitted between people, especially between the staff and children in nursery schools. The solution is technological: *Sensors [and] a display with a loading bar gives feedback. […] The child can follow the progress, [and it] will make the children remember to wash hands.* (tab 1 #5)

The pitch audience acknowledged the matter of hand hygiene.The group claimed that *handwashing is fun* (supervisors notes) but this part of the proposal is met with concern: Is it really fun for kids to watch a loading bar while washing hands?

The collective voting resulted in a score of 9.0 out of 40, a thought provoking feedback: The audience simply did not approve the proposal. It can be painful when you *have build ownership* (tab 1 #11), but the group noted pitch 1 as a turning point since it raised an important question: *What do kids think is fun?*

The workshop: The group decided to go back to the kindergarten for further exploration (tab 1 #6). The question was translated into another guiding question: *How to turn time of splashing into time of washing?* (tab 1 #5) To involve the kids the group featured an outdoor workshop with water filled boxes and a lot of plastic toys. The kids were invited to *splash and wash*.

Figur 2 (from left): a:The workshop. b: The duck. c: Artifacts from the workshop. d: Early prototype made from clay and covered with silicone.

The workshop was a relief for the group as they *got an incredible lot of data back home from the visit at the kindergarten* (tab 1 #11). The kids responded with an obvious joy (fig 2a). One artifact; the duck, caught attention (fig 2b*): The kids loved washing it together. But would they also do it alone in the restroom?* (tab #11)

According to the group, the Foamy soap dispenser was born as a proposal at the following brainstorm and modelling session (tab #11) where the group, mimicking children's modeling, created little funny figures (fig 2d).

Pitch 2: The group showed little clay-figures (fig 2d, 3a) and proposed that:

…we want to make the restroom a playground! Our solution, made in collaboration with the children, is a figure-shaped soap dispenser that you simply cannot help but touch. [It is] soft, elastic, smooth and attractive. The dispenser should give the children foam soap on their hands as they squeeze it! (tab 1 #7)

It caused the score 26.88, a remarkable jump and the pitch audience were instantly mobilized to debate the matter of silicone molding and the technology of the soap dispenser. In the supervisors' notes it is quoted that *bathrooms are boring*, and the notepad is filled with drafts for dispenser valves.

Figur 3 (from left) a,b: Early prototypes. c: Digital model. d: 3D printed mould. e: Prototype with foam.

Here followed a period of technological development where 3D printers showed great *actans*, using a term from ANT compliant with Storni's *Notion of Things as a social construct* [15].

The first attempts to make a silicone mould from the clay form wasn't promising (fig 3a, b) but a simple 3D model (fig 3c) and a 3D printed form (fig 3d) proved doable. The group managed to produce a number of Fomies for testing (fig 3e).

Test: A simple test design was carried out: Soap-filled Foamies with tiny dispenser-holes was deployed in the sink in a new kindergarten. A local pedagogue agreed to observe the kids and take notes, an agreement that prevented the students from disturbing the kids and the test.

The kids used the Fomies as intended and caught attention at the kindergarten. Some parents even asked where to buy them. New questions arised: Will the interest persist? What about the soap consumption and how to refill?

Pitch 3: The Foamy narrative begin to stabilize and the focus is now on the staging of the final pitch. At this point, the group proposes the matter with authenticity:

Children discover the world through their hands! When they get soap on their fingers, they wash it off! This led to the creation of Foamy! (tab 1 #9)

Everybody loved the Fomies and the class score increased even further to 28.11.

The last period of the course is intense. The students are busy producing prototypes, trying to answer soap dispenser related questions, rehearsing the pitch, preparing the Green Challenge scenography and designing the poster.

The matter is gradually further stabilized: Notes from supervision in the period: *The sink is a playground!*

The Oral Exam acts as a final rehearsal, the group passed and got feedback once again. After a few more rehearsals and optimizations of the pitchmanuscript and the choreography, they are ready for the final explications at Green Challenge.

Green Challenge is a special day to most students that participate. Many weeks of work converge. The groups will propose to Industry professionals, entrepreneurs, business angels, politicians and fellow students, and for many this event is an important step in a startup process or a research career, as many will gain confidence and also be introduced to important new contacts. The groups will have to explicate to strangers with different backgrounds. The Foamy Group has a nice scenography with sink, water, poster and a lot of Formies for the audience. They stick to the narrative but accentuate the economical argument:

Two million days of sick leave a year is registered at the Danish labour market - not because employees themselves are sick but because their children are. 30% of children's sick days can be attributed to hand hygiene. Foamy can save 600,000 sick days a year. We have been out in public kindergartens, playing with water with the children. They had fun. Children experience the world with their hands. When children get soap on their hands, they wash it off automatically. We put that information into a concept, brought it to Herlevgaard kindergarten and tested and that test gave us Foamy. Fomies are some crazy animals that live in the sink and the kids can't keep their hands off them. When the children hug them, soap comes on their hands. And then there's just one thing to do and it's to wash your hands. Foamy changes the behavior of the kids. We have presented to a hygienic nurse and a

doctor. They confirm that the way to better hand hygiene for children is to change behavior (tab #13)

Group 7 achieved a Green Challenge score of 26.33 which ranked Foamy as no. 9 out of 30 groups. One board member wrote: *Making better health a game. If implemented a revolution!* (tab 1 #13).

Further on

The Group was encouraged by the experience at the Green Challenge. Since GC, they have taken the project to another course and also formed a small enterprise, trying to get croudfunding. They continue to explicate their rising understanding of the matter of hygiene and children. If they respond properly to the present societal response and translate the Fomies accordingly, there might be another story to tell.

4 CONCLUDING SUMMARY

This paper proposes a design for an entrepreneurial course with the recurring explications as the driver. We argue that one single factor why the students do well in the Green Challenge is the recurring explications.

The story about Foamy exemplifies how our students, for each new explication, get their narrative more accurate, become more conscious about their audience and the societal context, and reach a new level of understanding, as the solution, in this case the Foamies, comes into being and matures.

The example stresses the interconnectedness between the depth and width of the understanding of the matter; children's hygiene in the kindergarten and its societal consequences on one hand, and the applicability and possible adaption of the solutions to a market on the other hand. As Lawson put it; problem and solution emerge together [7].

We claim that the story about Foamy is not unique. Since 2015 we have seen many of the kind, judging by the track record of our students in the Green Challenge. Also, explication is not restricted to a learning context. You might argue that using the Green Challenge as motivation for the students makes the whole thing unrealistic since it is ‘only’’ an university competition. We will argue the opposite. What motivates students most is to experience their proposal coming into being. In the present case, the students are not only rewarded with a grade (pass/failed, not much glamour about that), but by the response and engagement from numerous actors along the way, ranging from the kids to the professional members of the GC panel, proving they are making sense. In several cases, whereas Foamy is one, the students take the leap and form an enterprise. Whereafter they can expect an infinite chain of situations of explications while they aim to mobilize partners and customers, hopefully gaining the understanding of society, market and human behaviour, necessary to succeed. And so can the rest of us, pushing our projects forward within the walls of an organization, as exemplified in the preface.

4.1 Explication or feedback?

We claim that one single factor why the students do so well in the Green Challenge is the recurring explications. With reference to the VDI model one can ask what happens to the *understand, explore* part of the narrative? Also, isn't the feedback equal important to the explication? The learning circle is of course inseparable, but as an engineer, an innovator or an entrepreneur, you attempt to make an impact to the world. The situation of explication is the scene of your attempt, a situation where knowledge and opportunities converge and come into existence. Without the explication there might be, best case, a Nobel prize candidate manuscript hidden in the desk drawer, read by no one. The explication generates response to learn from. Feedback is one kind of response, often associated with the learning relation between teachers and students, but response is a lot more. Drift wet children, deeply engaged in washing a yellow plastic-duck in the kindergarten is a powerful response, confirming that the students in that particular moment are on the right track and make sense.

To summarize, the moment of explication can somehow be controlled. You can decide time and place and you can choose what to say and what to show. The feedback can be documented, processed and analysed, but the feedback itself, how exactly the kids make fun, is out of control but an important source to learn from. In this sense the Fomies is a gift from the kids in the kindergarten to Group 7.

4.2 Resistance and the learning curve

Internalization of the narrative of explication is not easy for students. There is a learning curve. As quoted above, the idea of personal ownership to a concept of great value is deeply embedded in society and painful to give up. But in a learning context we claim that to give up ownership and let go of ideas might be the far most important learning. Explication offers a perception that is in opposition to the mainstream judgmental 'make or break' narrative of the entrepreneurial pitch. Instead we claim that whatever you propose, you should consider it a probe, pay attention to the response and be ready to leave your believes behind. One other group attending the courses worked on a project for 13 weeks in the GE course, proposed it on PD pitch one, got feedback similar to what the Foamy group got, decided to give up the project, started all over with two weeks left - and won the Green Challenge.

With the two courses we intentionally give the students a lot of options to explicate their matter to an audience as diverse as possible. This, accompanied by the experience of bringing something into being facilitates the internalization of the narrative of explication.

4.3 Concluding remarks

The foamy example is only one out of nine from the year of 2019, that again is one year out of five where the described coursedesign has been carried out. The VDI model and the idea of recurring explication has likewise served as model at other courses and projects as well as innovation processes in professional arenas, e. g.

the international society of audiology [3]. The Foamy case is simple, at least from a technological perspective. Some might even call et simplistic. But the curriculum at the study program Process & Innovation aim to enpower the students to manage the socio-technological complexity of a multidiciplinary innovation process. From that perspective there is plenty of complexity and learning in the intention of making handwash fun for kids. The students will soon get involved with more advanced technology, byt then they are prepared to balance technology with human, cultural and economical factors troughout the process. Future research must explore the concept of explication in these more complex processes.

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