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Technarium Hackerspace: Community-Enabled Informal Learning in Science and Technology

Technariumo techninės kūrybos dirbtuvės: informalus mokslo ir technologijų mokymasis bendruomenėje

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SANTRAUKA

Naujųjų technologijų išmanymas bei gebėjimas susidoroti su kasdien mus bombarduojančiais informacijos srautais, bei priimti apgalvotus sprendimus, darosi vienos svarbiausių XXI amžiaus kompetencijų. Mokslo ir technologų kompetencijų ugdymas darosi viena svarbiausių temų pasauliniame ugdymo diskurse, tiek sureikšminant mokslo, technologijų, inžinerijos ir matematikos žinių įgijimą mokyklose, tiek mokymąsi už mokyklos ribų. Įdomu tai, jog informalus mokymasis, t.y. patirtys ir žinios įgytos kasdienėse erdvėse, pvz., darbovietėje, vietinėje bendruomenėje, laisvalaikio užsiėmimų metu, darosi vis svarbesnis visapusio ir visą gyvenimą trunkančio ugdymo kontekste.

Šiuo požiūriu darosi įdomus ir šiuo metu populiarėjantis „maker'ių" judėjimas, kuris, manoma, galėtų padėti „iš naujo išrasti" ugdymą bei paskatinti daugiau žmonių pasinaudoti praktinio informalaus ugdymo galimybės mokslo ir technologijų srityse. Šiame darbe analizuojamas Technariumas – techninės kūrybos dirbtuvės (hackerspace'as) Vilniuje – bei šios erdvės, kaip veiklos bendruomenės, potencialas informaliam mokslo ir technologijų kompetencijų mokymui(si).

Įvairių Technariumo bendruomenės aspektų, bei informalaus mokymosi atvejų analizė atskleidė, jog: 1) mokymasis dirbtuvių bendruomenėje yra sociali veikla, kuriai didelę įtaką daro žinių dalijimasis tarp narių; 2) Technariume vyrauja pozityvus požiūris į mokslo procesų suvokimą ir įvairių technologijų išnaudojimą, bei noras gerinti visuomenės mokslo ir technologijų išprusimą; 3) nors mokymasis nėra pagrindinis narių tikslas, jis beveik visada pastebimas ir vertinamas kaip „šalutinis" dalyvavimo dirbtuvių veiklose efektas; 4) įvairiapusės narių kompetencijos, persidengiančios veiklos bei įvairių įrankių gausa dirbtuvėse sukuria unikalias galimybes mokytis skirtingose srityse.

Šiuo darbu tikimasi padėti pagrindus techninių dirbtuvių (hackerspace'ų), kaip veiklos bendruomenių, tyrimams informalaus ugdymo srityje, bei pradėti tokių erdvių, kaip iki šiol neišnaudoto fenomeno, edukologinius tyrimus Lietuvoje.

SUMMARY

Being adept with the novel technologies, as well as able to confidently deal with the stream of information and data we are being bombarded with very day, becomes some of the main competences in the 21st century. Educational discourse worldwide has therefore been emphasizing the importance of gaining STEM skills both in schools, and out-of-school environments. In fact, informal learning opportunities, such as we are exposed to in our everyday lives, workplaces, local communities, hobbies etc., are gaining importance as a way to ensure full rounded and lifelong learning in science and technology.

As such, the currently spreading "maker movement" has been proposed as a creative way to "remake" education and involve more people in hands-on informal learning. The current study explores Technarium – a hackerspace in Vilnius, Lithuania – as a community of practice that creates diverse opportunities for informal learning in science and technology.

Analyses of the diverse Technarium community dynamics, as well as informal learning cases, reveals that: 1) learning is a socially embedded practice in the hackerspace, largely dependent on knowledge sharing between members; 2) the overall attitude of Technarium members is towards understanding of scientific phenomena and engaging with different technologies, as well as increasing the public understanding of science; 3) though learning is not the primary goal of members, it almost always happens as a "side-effect" of participation, and is greatly appreciated by the hackerspace members; 4) the diverse expertise of members, the overlapping nature of practices and availability of various tools create rich learning opportunities across disciplines.

This work aims to lay ground for research of hackerspaces as communities of practice in the context of informal learning, and introduce the as yet unrealized topic of such spaces to the Lithuanian educational landscape.

INTRODUCTION

Learning is becoming an urgent topic in the current fast-moving technological society of ours. People need skills to take advantage of the opportunities of new technology offer, competences to withstand the constant influx of information and data, and critically sift through informational noise to make informed decisions (Marincola, 2006; Sjøberg, 2002). Certain skills, such as programming, are becoming the "new literacies" of the Informational Age (Bybee & Fuchs, 2006). Learning science and technology, then, becomes one of the top priorities in the 21st century education. The necessity to expand and improve STEM[1] subject learning is emphasized in the agenda of Lithuania (*Lietuvos mokslo ir technologiju baltoji knyga*, 2001) and EU at large (Joyce & Dzoga, 2011), as well as the other parts of the world, including the US (Bybee, 2010; Kuenzi, 2008).

While a significant part of the educational discourse in this area has been directed towards improving STEM education in schools, including K-8 and K-12, the focus is slowly shifting towards alternative forms of improving science and technology competences, especially so in the context of lifelong learning. Bell et al. (2009) suggest that learning about science actually occurs "across all venues—everyday experiences, designed settings, and programs" (p. 2), and individuals of all ages and backgrounds can continue to learn science in informal settings. Mounting evidence suggests the success of alternative science and technology environments in facilitating learning, including museums (Dierking & Falk, 1994; Falk & Dierking, 2000; Rennie et al., 2003) and science centers (Brahms & Werner, 2013) and participatory environments, such as citizen science

[1] Science, Technology, Engineering, Mathematics.

(Bonney et al., 2009; Brossard, Lewenstein, & Bonney, 2005; Jordan et al, 2011; Kloetzer et al., 2013; and others).

The growing "maker movement" has also recently appeared under the educational radar, as a way to "remake" learning via active participation and "learning by doing" (Brahms & Werner, 2013; Halverson & Sheridan, 2014; West-Puckett, 2014). The maker movement includes the growing popularity of makerspaces, hackerspaces and fablabs, which have its roots in the DIY (do-it-yourself) culture, largely propelled by the growing availability of advanced technologies, such as 3D printing, laser cutting etc., as well as the growing programming literacy among the new generations. The makerspace/hackerspace landscape includes tinkering with various technology and science disciplines, including electronics, software and hardware engineering, physics, biosciences and various crafts. Moreover, this usually happens in shared spaces and communities, enabling often peer-supported learning across different fields. As spaces where diverse age, gender and culture groups can engage in "hands-on" activity at the interplay of digital and physical fabrication, makerspaces have been proposed as the "hubs" for innovation in the 21st century (Kera, 2014; Lindtner, Hertz, & Dourish, 2014; Peppler & Bender, 2013). The maker movement has been suggested as a possible way to "transform the educational landscape" (Halverson & Sheridan, 2014; Kalil, 2013), and new makerspaces have been popping up in universities, libraries and communities.

However, the literature on makerspaces has so far focused largely on "designing" spaces that would fulfil the certain "making" and educational requirements (Brahms & Werner, 2013; Colegrove, 2013; Halverson & Sheridan, 2014; Kurti, Kurti, & Fleming, 2014), including designing classrooms as makerspaces (West-Puckett, 2014). This "design" introduces pre-defined learning settings that are often formalized and monetized in the form of courses and regular

workshops. The literature so far has almost completely failed to recognize hackerspaces, as very specific types of makerspaces that are usually not attached to educational facilities, are not designed with the specific goal of learning in mind, and do not organize formalized learning (Van Holm, 2012). Hackerspaces, in contrast to other types of DIY hubs of the maker culture, have a long history of tinkering and passionate exploration in the domains of science and technology, as well as strong attitudes toward sharing knowledge and improving scientific understanding of the public, as the social context the hackers themselves are placed in (Himanen, 2001; Raison, 2010). This makes hackerspaces a very interesting object of study in the context of informal learning in science and technology.

Importantly, the few studies that have empirically studied *informal learning* in makerspaces/hackerspaces to date, constructionism seems to be the main theoretical approach, likely due to being a "perfect fit" for studying "learning in the making", i.e. active construction of things (Halverson & Sheridan, 2014; Raison, 2010; Sheridan et al., 2014). However, the social dimension of learning, such as it manifests in communities of practice (Wenger, 1998), seems to remain largely unexplored. While several studies have demonstrated the usefulness of communities of practice model in makerspaces (Halverson & Sheridan, 2014; Sheridan et al., 2014), these concern makerspaces that have been "designed" for learning, are not open to the public and/or provide monetized learning services. However in the studies of hackerspaces in particular, which differ in this regard (as defined in section 3.1), the few existing studies seem to dismiss the usefulness of communities of practice, or do not explore this approach at all (Kera, 2014; Kolko et al., 2012; Raison, 2010). This is striking in a sense that whole hacker mentality is embedded in social practice and peer-learning (Himanen, 2001).

Lastly, at the time of writing there have been no studies exploring learning in hackerspaces or makerspaces in Lithuania, and the phenomenon remains largely untapped in the country[2]. This work is therefore an attempt to describe the informal learning potential as it is enabled by the community of practice in the only hackerspace in Lithuania – Technarium[3], and lay basis for further study in the area, both in the context of local educational discourse, and the study of hackerspaces worldwide.

Aim. The main aim of this study is to explore Technarium hackerspace as a community of practice, in which rich opportunities for developing science and technology competences emerges on a daily basis.

Objectives:

- Define the main elements of the Technarium hackerspace that relate to the community of practice
- Explore the local "regime of competence" in the hackerspace, as it applies to members attitudes and expectations towards science and technology
- Explore the attitudes of Technarium members towards learning, and demonstrate the usefulness of the informal learning approach
- Identify and describe cases of informal science and technology learning in Technarium to demonstrate the scope of informal learning opportunities in the hackerspace

[2] The only known publication to date in Lithuania being "Open Source and Free Software Developer Communities as Virtual Organizations" by mic, coursework, Vilnius University, 2004: http://blog.hardcore.lt/mic/archives/mic%20-%20VIVA-1%20-%202004.pdf

[3] https://technariumas.lt/

Working hypotheses:

Hypothesis 1: Technarium carries many features of a community of practice, and the framework is useful to study informal learning in the hackerspace.

Hypothesis 2: learning happens informally and, sometimes, incidentally at Technarium, without being a primary goal of members.

Hypothesis 3: Technarium community creates a favorable environment to learn about science and technology due to the activities and attitudes of the hackerspace members.

Hypothesis 4: diverse member expertise, availability of tools and community dynamics create rich learning opportunities for most members.

Methodology. I approach the phenomenon of informal science and technology learning in Technarium via *communities of practice* model, embedded in the theory of *situated learning* by Lave & Wenger (1991). The empirical study carried out is based on qualitative methodology, particularly ethnographic study (Lorenz & Barlatier, 2007), supplemented by unstructured and semi-structured interviews with Technarium members.

Structure of thesis. This work is structured as follows: Chapters 1-3 explore the methodological approach to the object of study, namely the informal learning of science and technology in the Technarium hackerspace, as a community of practice. Chapter 1 explores the theoretical underpinnings of informal learning in science and technology, Chapter 2 – communities of practice as medium for learning, and Chapter 3 – hackerspaces as a creative spaces with potential in education. Finally, Chapter 4 describes the empirical study carried out in the Technarium hackerspace, as the main object of study in this work.

1. INFORMAL LEARNING IN SCIENCE AND TECHNOLOGY

The current section describes the theoretical basis of informal learning, its distinction from the other types of learning commonly identified in educational discourse, including formal and non-formal learning, relevant learning theories, and the relevance of informal science and technology learning in the current educational landscape.

1.1.What is informal learning?

In educational terms, informal learning, as opposed to formal or non-formal learning (see a comparison of all three types of learning in Table 1), could be considered as the broadest and the most diverse set of learning experiences available to an individual. In contrast to formal, which happens in highly structured school and other educational environments, informal learning can happen in everyday settings, while engaged in a usual activity, such as reading a paper or a magazine, visiting a museum, engaging in an interesting conversation with a friend and so on (Marsick & Watkins, 1990).

Table 1. Formal, non-formal and informal learning: a brief comparison. Based on Mocker & Spear (1982), Eshach (2007), Colardyn & Bjornavold (2004).

	FORMAL	**NON-FORMAL**	**INFORMAL**
Environments	Designed for learning	Mostly designed for learning	Could be any environment
Example environments	*School, in-company training*	*After-school club, arts class*	*Museum, workshop, everyday settings*
Curricula /program	Structured	Structured	Unstructured
Planning	Pre-arranged	Pre-arranged	Spontaneous
Learner's motivation	Extrinsic	Intrinsic or extrinsic	Intrinsic

Learner's control	Little control over means & objectives	Control over objectives, but not means	Control over means, but less so over objectives/outcomes
Learner's role in process	Teacher-led	Usually teacher- or mentor-led	Learner-led
Dominant form of evaluation	Formal evaluation (e.g. tests, exams, coursework)	Various formalized evaluations or none; verbal feedback; self-evaluation	Peer-recognition, self-evaluation

Fascinatingly, informal learning is not only common, but also the most fundamental and natural form of learning available to an individual. According to the Committee on Learning Science in Informal Environments in the US (Bell et al., 2009), individuals learn about the natural world continuously "[a]cross the life span, from infancy to late adulthood" (p.2). This learning happens in a multitude of environments, including 1) everyday settings, e.g. a child asking his parents about why their house has a sloping roof (p.100); 2) designed spaces, such as museums, zoos and environmental centers where people can experience natural phenomena at their leisure; 3) structured science programs that transcend formal school settings, which are set up by science-rich organizations or community groups to advance science learning of participants; 4) science media in forms of TV, radio, the Internet, handheld devices; and others.

One of the main factors separating informal from other types of learning, however, is not only the environments where it occurs (indeed, these environments can overlap, such as an informal science program set up in school or students learning from their peers outside of classes), but the nature of learning itself. Informal learning is almost exclusively self-directed (albeit, not always conscious), i.e. the learners themselves ask the questions that matter most to them,

engage in activities or visit places that carries the most interest to them, and so on (Eshach, 2007; Livingstone, 2001; Marsick & Watkins, 2001; Bell et al., 2009)

Importantly, informal learning can be either planned, i.e. environments and activities set up or participated in with the explicit goal of learning in mind, or *incidental*, in which learning happens as a by-product of another activity, conversation or experience (Marsick & Watkins, 2001). For example, a child asking about a sloping roof, and then getting an explanation for this particular architecture, could easily be considered as incidental learning, as his question is driven by plain curiosity, and he almost certainly does not have an explicit goal of gaining knowledge of basic roof architecture in mind. Adults experience very similar cases of incidental learning in their everyday lives too, e.g. by starting a conversation with a friend or peer at work out of boredom, curiosity or incidence, not thinking about it being a specific opportunity to learn something neither before nor after the experience takes place. As such, incidental learning is particularly curious from an educational perspective, as it "almost always takes place although people are not always conscious of it"(Marsick & Watkins, 1990, p.12).

Another key factor that commonly distinguishes learning in informal settings is that it is usually driven by mentorship and peer support, not authoritative instruction, as is common in most traditional formal learning environments (Lave & Wenger, 1991; Marsick & Watkins, 2001; Watkins & Marsick, 1993). Moreover, informal learning, in contrast to the other types of learning, is mostly based on experience, and does not happen in a vacuum. According to Marsick & Watkins (2001), "learning grows out of everyday encounters while working and living in a given context" (p. 29). This may be a challenge or a problem to be solved in an everyday environment, such within home

or work routines (Ibid.), incidental or planned experience that arises by observation and active participation in a community (Lave & Wenger, 1991) etc.

In such a way, informal learning is intrinsically learner-centered, rather than following a tight structure and curriculum imposed by an institutional learning body or a generalized educational policy. Such focus on the learner, rather than program and/or formal curriculum, carries major potential in the current educational landscape, where focus is shifting for overly standardized curricula to individualized, experience-based learning that is both more meaningful and more approachable to diverse learners, including those from marginalized communities (Brown, 2003; Keengwe, Onchwari, & Onchwari, 2009; Bell et al., 2002).

According to (Marsick & Watkins, 2001), "informal and incidental learning are relevant to practice in many cultures and contexts", including workplaces, colleges, universities and schools, professional associations, museums and other informal spaces, families and communities. Curiously, informal spaces, including libraries, churches and museums, where also the very places where formal education sparked in the 19th century (Bell et al., 2009), yet have been largely overlooked in the educational landscape. Even though informal learning is an intrinsic part of our everyday lives, and is estimated to account for most of our time spent learning as such (as compared to school, for example, where we only spend a fraction of our time) the research focus it receives is still marginal compared to formal education (Bell, 2009). Yet, as suggested by Marsick & Watkins (2001) theory of informal and incidental learning, "informal and incidental learning take place wherever people have the need, motivation, and opportunity for learning" (p. 28), which constitutes a wide spectrum of opportunities, processes and outcomes to be studied in the educational context.

1.2.Learning science and technology informally

Science and technology education is becoming an urgent topic in the current educational landscape, both due to the increasing role that these disciplines play in our environment, and due to alarmingly low levels of scientific understanding amongst the public and low popularity of scientific careers (Marincola, 2006; Sjøberg, 2002). The understanding of *science* involves the general explanation of real life phenomena, which may concern the environment, human health, or other fundamental topics, as well as the understanding of the scientific process itself, i.e. how discoveries are made that concern our natural world (Bell, 2009). *Technology*, on the other hand, is the tools and processes with which we explore & manipulate our natural environment. Technologies may depend on scientific discoveries or, on the contrary, drive them forward. Needless to say, both are gaining importance in our fast-moving world – being adept with technology is becoming one of the "literacies" of the 21st century, while the understanding of science – a tool for critical thinking in the age of information and (Marincola, 2006; Sjøberg, 2002).

Science and technology education has been part of the educational discourse for a few decades, however major changes in the way these topics are approached are yet to be seen (Marincola, 2006; Sjøberg, 2002). Importantly, even though most of the efforts have been concentrated on STEM education in K-12 and other forms of formal education (Bybee & Fuchs, 2006), the focus is slowly shifting towards other types of learning, including informal learning, in developing competences in science and technology, especially so in the context of lifelong learning (Bell et al., 2009). Moreover,

According to Bell et al. (2009), it is always most sensible pursue the "ecological" approach to learning, i.e. connecting all the different places and environments in our development, including, for example, everyday experiences

and schools. Formal environments, however, are actually those where we spend the least amount of time in our lifetimes[4] and, therefore, might not be the best – and certainly should not be the only – focus for learning the fundamentals of our everyday lives, which are encompassed largely by science. Moreover, as demonstrated by some authors, failing a science subject in school does not prevent children to show competence on the same subject in out-of-school context, which urges to rethink the formal education settings, or at least put less emphasis into the latter and more resources into teaching science and technology in non-formal and informal settings instead (Bell et al., 2009). As Bell et al. (2009) put it, to deal with the growing needs to have a scientifically and technologically savvy society, issues, we will have to "draw creatively on all available resources to improve science literacy" (p. 12.)

Importantly, while we may not actively reflect on this every day, science learning is actually intrinsic to our daily lives and/or hobbies. A classic example is a child asking a parent a question (e.g. why is the sky blue) driven by basic curiosity. Adults, in turn, learn by participating in conversation, be it with children when answers to their questions first need to be discovered for adults themselves, or with peers, e.g. in a workplace or leisure environment. The media and various leisure activities (such as visiting a museum) can be an important source of science learning as well, both for adults and for children.

Moreover, according to Bell et al. (2009), activities in embedded in nature, such as "fishing, berry picking, agricultural practices, and gardening" are "clearly tied to science content" (p. 95). However, I argue that such natural practices have been removed too far from most urban lifestyles and are unlikely to be pursued in often enough to learn significant amounts about science and technology. Instead, some "creative" environments, such as citizen science

[4] According to some authors, as little as 9% of our lives are spent in schools (Bell et al., 2009).

(Bonney et al., 2009; Brossard, Lewenstein, & Bonney, 2005; Jordan et al, 2011; Kloetzer et al., 2013; and others) and hackerspaces/makerspaces discussed in this work (Kera, 2014; Litts, 2015; Raison, 2010; Sheridan et al., 2014; and others), as well as more traditional museums (Dierking & Falk, 1994; Falk & Dierking, 2000; Rennie et al., 2003), have been demonstrated as successful informal venues for learning about science and technology, and might just be the contemporary solution to filling these gaps.

Lastly, it is important to mention that learning of science and technology is a fundamental part of lifelong learning in a technological society, such as ours. Learning science and technology should "teach thinking, not facts" (Marincola, 2006, p. 2), which ensures we create a society "where well-educated adults are equipped to bring scientific thinking to bear on issues that affect them as citizens" (ibid.). That becomes a very important point in the light of controversial issues that we face as a society, e.g. climate change, GMOs, the effectiveness of vaccinations and so on. Ability to evaluate scientific claims critically would ensure informed decision making and less misconceptions about scientific. According to Bell et al. (2009), however, informal learning settings accomplish exactly that: "learners may develop awareness, interest, motivation, social competencies, and practices. They may develop incremental knowledge, habits of mind, and identities that set them on a trajectory to learn more." (p. 27). This is crucial to ensure continuing learning and informed survival in the complicated settings of today's world.

1.3.Informal learning theory: overview

Informal learning has been approached via a variety of theoretical perspectives in the past, among which constructivism, social constructivism and experiential learning remain some of the main approaches. To start with,

constructivism, proposed by Jean Piaget some 60 years ago (Fosnot, 2013), deals with the fundamental nature of each of us a learners to adapt and accommodate new knowledge according to the previously gained experience, and well as the direction we choose pursue or question we choose to asked. Constructivism therefore serves as the basis for many learning theories focused on the influence of context rather than assimilation of external fact as is.

White Piaget's original theory deals mostly to the construction of knowledge as it concerns an individual learning, *social constructivism* deals with the influence of social context on each individual's learning (Powell & Kalina, 2009). Social constructivism has its roots in a theoretical framework of *sociocultural learning* proposed by Lev Vygotsky (1978), which suggests that individual cognition forms in response to her social environment. The theory emphasizes the cultural origins of human development, and the "zone of proximal development", which suggest individual development does not occur in isolation, but is embedded in cultural and social context instead. In turn, social constructivism defines the construction of knowledge, not simply by exploring in isolation, but, fundamentally, as influence by one's social world.

Experiential learning, which can largely be traced to the work of John Dewey (1938), focuses on the role of active exploration ("learning by doing") and lived-in experience in the development of each learner. Dewey suggests the "experimental method" should be the basis to exploring and understanding phenomena, through which – also our entire natural world, including the society we live in.

The three theoretical frameworks have given rise to a number of learning theories and models, including Seymour Papert's *constructionism* (Ackermann, 2001), which advocated that knowledge construction is best mediated through active construction of things, usually in the physical world, and

solving problems as they arise; and *situated learning* by (Lave & Wenger, 1991), which suggests learning is fundamentally socially constructed experience, dependent on the context of one's everyday environment, and introduces the concept of *communities of practices*, which facilitate the process of learning around a particular domain and practice.

The latter two theoretical frameworks: constructionism and communities of practice, have been widely assess in "hands-on" cases of informal learning (Bell et al., 2009), and are particularly useful in the context of informal learning in science and education.

2. COMMUNITIES OF PRACTICE AS MEDIUM FOR LEARNING

The concept of communities of practice was proposed by Lave & Wenger (1991) and is embedded within a larger theory of *situated learning*, and has since been used to explore learning in a variety of different settings. The theory of situated learning itself concerns experiences that, instead of happening in isolation (such memorizing a mathematics theorem by the book in class), are "situated" in the activity and context in which the learning takes places (such carrying out a construction project, or learning to function successfully in a particular trade, community etc.).

Situated learning defines the role of each learner as a "negotiator of meaning" who is in a constant and *interdependent* relationship with their social and cultural environment. Moreover, rather than being a one-off experience, such learning always carries a historical context as well, grounded in a continuous relationship between the phenomenon and the individual, the history of the phenomenon within the social context of the individual, the language and tools that have been used to negotiate meaning about the phenomenon and so on.

The theoretical approach of situated learning emphasizes the "concerned and interested character of thought and action of persons engaged in activity" (p. 67). This point carries particular significance in the context of informal learning, particularly so in adult learning, both of which are carry the learner-centered requirement to be successful.

2.1.What are communities of practice?

Interestingly, in their definition of the theory of situated learning Lave & Wenger (1991) use the terms "situated learning" and "situated social practice" interchangeably. This is particularly significant as we approach the main mechanism proposed to facilitate situated learning as such – the *communities of*

practice. The definition itself suggests that whatever learning takes place, it happens so within the community. However, it is important to realize that the community here is considered a medium to facilitate and support individual learning, and does not necessary concern learning at the community level, i.e. increasing the knowledge ability or skill levels of a certain group as a whole. Nevertheless, the model of community of practice highlights the importance of the social environment and the constant relationship between the individual and the social context to achieve one's learning.

To understand the concept as originally intended by Lave & Wenger (1991) and Wenger (1998), one needs to define what is meant by the "community of practice" as a whole. Importantly, *community* here is not meant to depict a community in the most common sense, i.e. any group or network of people, e.g. living in a certain place or having a shared interest etc. For example, people living in a certain neighborhood might be considered a community; everyone owning a skateboard might consider themselves belonging to the worldwide skateboarding community and so on. However, neither of these constitutes a *community of practice*.

According to Wenger (2005), "Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (p.1). The three fundamental dimensions of such communities include:

1) **The domain** – a shared domain of interest that members of the community are committed to. This could be anything from a particular hobby to gang living on the streets. Each domain has a specific set of competences associated with it, i.e. to be successful at a particular hobby one needs to have specific skills and experience; to be able to survive the gang life on the streets one needs to be able to adopt a specific language, habits and

> statues that allows one to be a functional member of the gang community. As succinctly put by Wenger (2005), [t]he domain is not necessarily something recognized as "expertise" outside the community" (p. 1), suggesting what is learned within the domain might largely be relevant to maintaining successful membership within the domain itself, e.g. gang life. However, depending on the context and the nature of the domain, the competences gained might be largely transferable. For example, skills gained while training for a climbing competition can have a positive effect on maintaining one's fitness later in life; knowledge gained on the best training techniques, nutrition or other relevant topics might help one to shift from a regular participant to a trainer of climbing; the social competence gained while working with the other people on the training team might come in useful in myriad lifetime situations; and so on.

Importantly for the later discourse on the success of communities of practice as mediators of learning, is also the issue of membership in the community, which, in Wenger's view "implies a *commitment* [emphasis added – EMR] to the domain, and therefore a shared competence that distinguishes members from other people" (ibid.). In such a way, the success of the individual within a particular domain, concerning becoming a legitimate member and succeeding in one's learning, depends primarily on one's commitment to be an active part of the domain. I.e., it is not enough to "like" climbing as such, as this does not imply commitment to climber community, and hardly ever translates to significant practice within the domain (where the "domain" is climbing itself). This therefore signifies the need to commit more than one's interest in any particular domain to become part of a community of practice, even though the interest is often one of the primary factors driving such involvement.

2) **The community** – being active in a particular domain of interest could be an isolated activity in principle; however the dimension of interaction and sharing with other members of the community is the fundamental aspect of the communities of practice model. According to Wenger (2005), members of a community of practice "engage in joint activities and discussions, help each other, and share information" (p. 1). Even more importantly, "[t]hey build relationships that enable them to learn from each other" (ibid.). This highlights the social dimension of learning involved in the model, a phenomenon also identified as *mutual engagement* in Wenger's earlier works (Wenger, 1998). The fundamental nature of mutual engagement drives the constant iteration of information and *negotiation of meaning* within the community of practice, making any learning a socially constructed and dynamic process that affects the learner as much as the learner affects the process (see section 2.2 Learning and identity). It is also closely linked to the issue of *mutual accountability*, which will become relevant later in this work as one of the constructs driving the success of a community of practice.

Sharing of knowledge, as well as tools and resources that have accumulated during the history of the community, are also fundamental defining factors of a community of practice. By continuing engagement in the same community of practice, its participants build relationship and learn from each other, rather than doing so in isolation. In the sense of informal learning, the abundance and variety of interactions also creates a wide range of learning opportunities, chances to ask and answer diverse questions, be exposed to diverse problems and experiences that other members bring to the group.

It is important to mention, that even though learning, according to this model, happens *in* a community, i.e. the community is a medium for learning

to occur, just as a museum or another designated space would be, however the model still concerns individual learning above all, i.e. what skills, knowledge and competence is gained *by the individual* in the end, not the resultant "group intelligence" or joint competency of the community as a whole. However, according to Jean Lave (Lave & Wenger, 1991): "Learning (…) is neither wholly subjective nor fully encompassed in social interaction, and it is not constituted separately from the social world (with its own structures and meanings) of which it is part" (p. 64). Instead, learning in the community of practice model entails a constant interplay between the individual and the community.

3) **The practice** – belonging to a networked community of peers who are interested in a particular domain does not constitute a community of practice, unless the explicit "practice" is involved. This dimension, again, signifies the distinction of a community of practice from a community of interest – "liking" any particular domain and discussing it with your peers is not enough. "Members of a community of practice are practitioners" (ibid., p. 2), suggesting the domain is always explored via active creation, construction, production of knowledge and so on. This practical dimension might be more obvious in some communities than others, e.g. skateboarding enthusiasts establishing a community workshop for recycling broken skateboards. However, the "practice" here, as proposed by Lave & Wenger (1991), Wenger (1998, 2005, 2010) and others, can take on myriad forms, e.g. advancing the knowledge of climbing practices, which might manifest as the collective creation of a "climbing wiki" or a similar resource; developing unique modes of communication and collaboration that allow survival in marginal environments, such as the streets; and so on.

Recently, the model of communities of practice has also extended to virtual communities (Hildreth & Kimble, 2004; Jacobson, 2008; Murillo, 2008), even though to some they might not seem to fit the "practitioner" status as they are not engaged in any "physical" practice. However, with the changing technologies, methods, and practices of knowledge construction, it is rational to extent the concept of communities of practice to unconventional practices. For example, citizen cyberscience has been recently demonstrated to show many features of communities of practice (Wiggins and Crowston, 2011). In this context, however, participatory knowledge production occurs exclusively online, and these platforms aid learning in many dimensions, including scientific understanding (Kloetzer et al., 2013).

Importantly, the dimension of *practice* encompasses more than just the basic deed of making something, including virtual "products" and the production of knowledge. Being involved in the practice of a community of practice also means drawing from the pool of resources (or *shared repertoire*) available within the community, including practical tools (such as physical building tools, virtual creation tools etc.), protocols and ways to address specific problems, experiences accumulated within the community, and even language and stories (Wenger, 1998, 2005). The latter is curious in a sense, as stories, even gossip, may not immediately seem like a vital resource while engaging in the pragmatic production of physical or abstract "things". Yet, the model originally proposed by Lave & Wenger (1991) entails that to *learn* is to be successful in the community you are part of, and engage productively in its enterprise, which may very well be learned by absorbing the overall culture of the community, it's stories, gossip, artifacts and anecdotes. Doing so efficiently, also means learning the specific language and communication strategies within the community in question, all of which could be considered the resource pool of the community.

In the current definition of a community of practice, all three dimensions are required. This allows for a range of diversity when identifying communities of practice in life. They can range from rather obvious apprenticeship programs, to cases of tribal knowledge transmission, cultures that emerge within the institutional structure in schools, colleges, universities and workplaces, as well as some less obvious cases, such as AA clubs (Lave & Wenger, 1991; Wenger, 1998). That is besides the virtual communities of practice that, in one way or another, fit the criteria across the three proposed dimensions (Murillo, 2008).

2.2.Learning and identity

According to Lave & Wenger (1991), learning is fundamentally embedded into its sociocultural and historic context (i.e. a "socially situated activity"), which helps to define *learning* as the "emerging property of whole persons' legitimate peripheral participation in communities of practice" (p. 63). In other words, to learn is to become a successful participant in a said community.

In this regard Lave & Wenger (1991), as well as later works, use the terminology of legitimate peripheral participation and full participation, which is at the core of learning in the community and will be useful to define the process of learning in this work. To be a legitimate peripheral participant is to enter the community, share at least some of its values and the expected skills, and to participate successfully in its practice. However, to become a full participant entails to 1) gain the skills and competences expected of you by your peers (see below); 2) learn the "language" and ways of communication that is specific to the community; 3) share the values and attitudes of the community at large; and 4) understand the community's history, appreciate its shared repertoire (including products, stories, anecdotes, even gossip) and participate fully in its creation. This way each members learns individually, yet, this learning "is neither wholly

subjective nor fully encompassed in social interaction, and it is not constituted separately from the social world" (ibid, p. 64).

Referring back to the dimension of domain, it is important that each domain, such as gang living on the streets, has a set of competences unique to it. To be successful in the domain is then to become competent in that specific sense (even if such "expertise" is not recognized beyond the domain itself).

However, that does not simply mean that any new members need to *comply* to the existing expectations within the community they are attempting to join, but, according to Wenger (2010) each member shapes the "regime of competence" in the community. Becoming a full member involves *realignment* with the community's "regime", which means the expected competence of the community drives new experiences of the participant, as much as the carried experiences of the participant become part of the community's regime of competence. In such a way, the individual and the community are involved in a constant and dynamic mutual engagement enabled by participation and reification. Realignment, and becoming a full member through realignment, is precisely where *learning* in the community of practice takes place (also see section 2.2 Learning and identity). The "set of criteria" or expectations which define that realignment has occurred, i.e., the participant has learned and is a member of the community, according to Wenger, 2010, are primarily:

- "Understanding what matters" and what the community is about;
- *"*Being able (and allowed) to engage productively with others in the community";
- "Using appropriately the repertoire of resources that the community has accumulated through its history of learning." *(p. 2).*

Under these terms, learning to be a member of a skateboard recycling community, for example, entails one learning the goals and philosophy of the

community, the practical basics and tricks of the trade, is aware of its historic artifacts, shares inside & travelling jokes etc. That is not to say all members are universally realigned with the community; far from it – the model allows to interpret learning as a never-ending process with multiple levels of identity change, in which not only the community changes the participant, but each participant changes a community. According to (Lave & Wenger, 1991) such dynamism is also one of the survival criteria for any such community of practice, in which the becoming of full participant requires both "the production of continuity with, and the displacement of, the practice of oldtimers" (p. 74). That also highlights the interdependency experienced while learning in the community, since "[n]ewcomers and oldtimers are dependent on each other: newcomers in order to learn, and oldtimers in order to carry on the community of practice." (ibid.). Fundamentally, "the success of both new and old members depends on the eventual replacement of oldtimers by newcomers-become-oldtimers themselves". (ibid.)

3. HACKERSPACES: PLACES, PRACTICES AND MOVEMENT

Hackerspaces are a part of a growing movement that includes the maker, DIY culture and is, in many cases, in the lead of developing and using innovative technologies, including 3D printing, laser cutting, CNC (computer numerical control) machines etc. While there are a variety of such spaces – garages, workshops, studios, labs, where the "making" of things happens with use of creative technology, they are most commonly defined as either hackerspaces, makerspaces or fablabs. All three types of spaces have been explored in the context of education (Halverson & Sheridan, 2014; Raison, 2010; and others), as a way to "rekindle" or "reinvent" education for different ages, and increase "literacy in design, science, technology, engineering, art, and math" (Dougherty, 2012-04-04). It is, however, important to make a distinction between the different terms that represent different types of spaces, as well as their approach and/or attitude to learning.

3.1.Distinction between hackerspaces, makerspaces and fablabs

Even though the terms "hackerspace", "makerspace" and "fablab" have been used synonymously in many contexts, multiple authors (Colegrove, 2013; Horvath & Cameron, 2015; Van Holm, 2012)[5], advocate against such usage. To start with, a "makerspace" is the most general term that can encompass both hackerspaces and fablabs, and is associated broadly with the DIY culture. The term could generally be traced to the well-known *Make* magazine[6], which has been established by Dale Dougherty in 2005. The general nature of the term, and its deliberate detachment from any specific technical meaning, is well illustrated by Dougherty himself (2012):

[5] As well as hackers themselves.
[6] http://makezine.com/

I make an effort to stay away from the word "inventor"—most people just don't identify themselves that way. "Maker," on the other hand, describes each one of us, no matter how we live our lives or what our goals might be. We all are makers: as cooks preparing food for our families, as gardeners, as knitters.

"Making", then, can be descriptive for all the different types places and organizations that concern themselves with DIY activities (Colegrove, 2013). I will therefore use "makerspaces" as a general term to define all the types of spaces that may identify with hackerspaces, fablabs, makerspaces etc. in this work.

Importantly, while the term "makerspaces" can be used rather loosely and include many types of activities, fablabs and hackerspaces *do* have a more technical meaning attached to them. Fablabs, for instance, maintain a particular focus on *fab*rication technologies, and one of defining elements of a fablab is the availability of 3D printing, CNC, laser cutting tools etc. (Gershenfeld, 2008). Importantly, fablabs have a more pronounced focus on education, and are often attached to educational institutions, e.g. colleges, schools and universities, and are rarely independent organizations (Van Holm, 2012). Naturally, this also shapes the focus of activities and membership, e.g. some fablabs are not open to the public, and include formalized educational content, such as courses and workshops.

Hackerspaces are distinct from fablabs and most other makerspaces in several ways. First of all, hackerspaces have been traditionally associated with "hacking" as a way of tinkering with computer technologies and programming[7],

[7] Note that "hacking" here does not mean "criminal behavior on the internet", which is how the term is commonly used in the media. Instead, "hacking" is used in the context in the "hacker culture", defined as "a subculture of individuals who enjoy the intellectual challenge of creatively overcoming and circumventing limitations of systems to achieve novel and clever outcome" (https://en.wikipedia.org/wiki/Hacker_culture).

which is not always a core part of other types of makerspaces. While Dougherty (2012) wanted to avoid the term "inventing" to describe *all* making, it certainly fits in the context of hackerspaces. In fact, exploring, tinkering, building and pushing the boundaries of technology is one of the most profound values in the hacker culture (Moilanen, 2012). Importantly, hackerspaces are largely describes as informal community places, where no formal education takes place. Regardless, the rich practices and the open attitude of hackerspace communities has been argued to lead to informal and inadvertent learning, which might play a fundamental part in learner-centered life-long education (Bell et al., 2009).

3.2.The hacker movement

Some sources trace the beginnings of the hacker culture to 1960s, when people started fiddling with computer systems not only for work, but also for enjoyment (Lindtner et al., 2014). Homebrew Computer Club[8], which met in Silicon Valley from 1975 to 1986, and where the beginnings of Apple took place could also be called one of the early hackerspaces –hobbyist meeting informally in a garage to work on DIY computer devices (Van Holm, 2012). However, the last "wave" of the hackerspace movement, is traced back to a German hackerspace c-base, which was established in a crashed spaceship in the center of Berlin in 1995 (Lindtner et al., 2014), and is sometimes considered the "mothership" of all hackerspaces by hackers themselves. The movement then spread through Europe and North America in an astounding rate. According to Hackerspaces.org[9] – the largest hackerspace resource in the world – there are currently 1254 active hackerspaces worldwide (2045 including closed and planned spaces). Technarium is the only listed hackerspace in Lithuania.

[8] https://en.wikipedia.org/wiki/Homebrew_Computer_Club
[9] https://wiki.hackerspaces.org/List_of_Hacker_Spaces

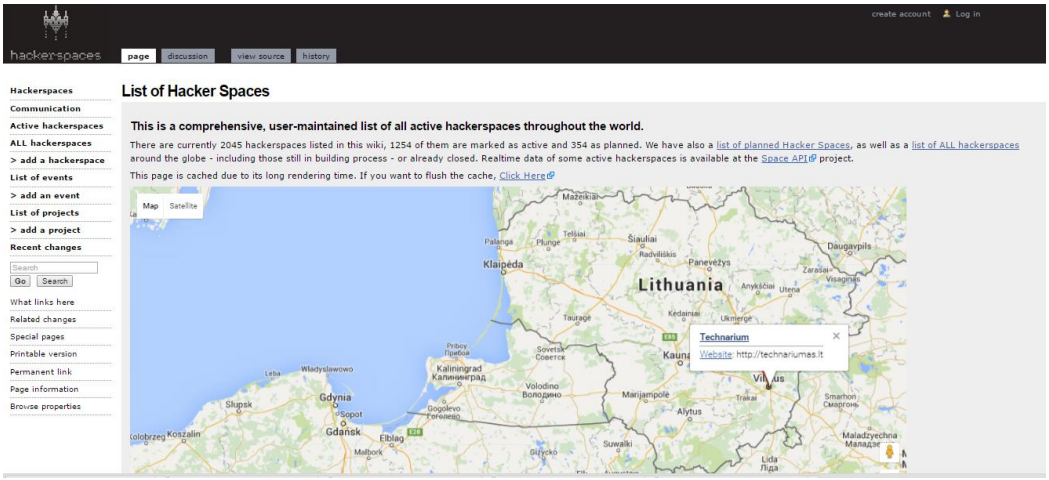


Figure 1. Screenshot of hackerspaces.org hackerspace map of Lithuania. As of 2016-05-30, there is only one hackerspace listed in the country.

In contrast to the original connotation of hacker culture with programming and computer technology, "hacking", as it is currently understood, can be considered as mastery and improvement of any technology or thing, including both digital and physical things. In this sense, the contemporary hacker practice "extends and in part remakes earlier hacker practice" and is reinventing manufacturing and innovation in hardware (Lindtner et al., 2014, p. 441). Many hackers believe that largely "anything" could be hacked, i.e. improved and made to fit one's needs, even to the level of social hacking. According to Moilanen (2012), "In the broadest sense hackers see the society as a system which can be hacked" (p. 94). Any medium or phenomenon can then, in principle, be bent to the hacker's will:

A hacker is one who yearns to understand the basic principles of phenomena. A hacker uses the Occam's razor to "scratch the syntactic frosting off" and peel the layers of a phenomenon until only the essence remains. This way a hacker is not necessarily just a programmer or a computer expert. There could be a hacker-carpenter, a hacker-mathematician, a hacker-philologist, a hacker-designer. The most important thing is passion.[10]

[10] Albertas Mickėnas at What's Next 2015 conference, https://technariumas.lt/WhatsNext2015.html

This definition will be important in studying the complex structure of Technarium hackerspace community in the context of this work.

Importantly, one of the most defining factors of those who identify themselves with the hacker culture, including communities in hackerspaces, is the adherence to the "hacker ethic", as it is described in Himanen (2001). *Passion* is indeed one of the main values ascribed to the hacker ethic: hackers tend to work on things that are "of intrinsic interest to them" (p.3-4) and that they can pursue enthusiastically and joyfully. More importantly, this goes in hand with the *freedom* to design own lives and work whenever and however one is most comfortable working. According to Linus Torvalds, the creator of Linux operating system, the basic survival needs that drive most people's motivation for work, are not of concern to a hacker. Instead, (and in case of Linux hackers) the reason they do something is "that they find it very interesting and they like to share this interesting thing with others" (ibid, p. xvii). This also adds the second dimension of the hacker ethic – ability to share your work and knowledge with others, which, according to L. Torvalds, is the highest motivation for hackers as it can be.

The social dimension or *social worth* is also one of the fundamental aspects of the hacker ethic, and is key to the formation of hackerspaces as communities, where like-minded individuals can share space, knowledge and tools to work on things of concern to them. Himanen (2001) explains this as the intrinsic human need for "experience of being part of a *We* with some other, the experience of being a respected *He* or *She* within some community and the experience of being a special *I* with someone else" (p. 48). The importance of a community and peer-recognition is often voiced by the creators and members of hackerspaces. For example, Moilanen (2012) in a study looking at peer-production sites, such as hackerspaces, found that "hackerspace communities have a strong 'social motivation factor'", which is why "members in the communities have a high interest towards meeting other hacker-minded people in real life" (p. 107). In fact, meeting people in real world, community commitment and altruism have been found to be the most motivating factors of motivation in hackerspaces. This is particularly important in studying social dynamics, as they lead to learning opportunities in a

hackerspace. Especially because, as Himanen (2001) suggests, "A prime strength of the hacker learning model lies in the fact that a hacker's learning teaches others" (p. 74), as a hacker constantly pushes the understanding of things further, and shares his knowledge with others.

This leads to the next fundamental point of the hacker ethic – *openness*, such as the open sharing of your work (including the details of the creative process) with the community at large, which is the core of the open source software and open hardware movement (Lindtner et al., 2014). The ability to share is, of course, a pre-requirement to get peer-recognition, and therefore gain social worth. Even more importantly so, hackers believe the economy of knowledge gaining lies in the ability to learn within the community and by contributing something, gain even more in return as the community discusses and improves upon your work (Himanen, 2001).

On top of that, The Hacker Ethic ascribes great value to *activity*, *creativity* and *caring*. In a recent report[11], sociologist Michel Lallement calls this phenomenon a "doocracy" – those who "do" receive the highest respect in the hacker community. This includes moving away from consuming, but making and investing instead; as well as finding a way to "do" something in situations where most people would say "impossible". Importantly, activity goes hand in hand with caring, which is "concern for others" be it just fostering of the community of hackers, or caring for the environment one lives in. Creativity, then, is the way to achieve all of those goals, "the imaginative use of one's own abilities, the surprising continuous surpassing of oneself, and the giving to the world of a genuinely valuable new contribution" (Himanen, 2001, p.141).

[11] http://www.makery.info/en/2015/05/04/michel-lallement-a-noisebridge-est-legitime-celui-qui-fait/

In this work, I am going to explore the social dimension of Technarium – a hackerspace in Vilnius, Lithuania, whose members are self-identified hackers and passionate followers of the hacker ethic.

4. ETHNOGRAPHIC STUDY: INFORMAL LEARNING IN SCIENCE AND TECHNOLOGY AT TECHNARIUM HACKERSPACE

Some would argue that makerspaces and hackerspace are model communities of practice, as they represent the building and creation of products within a shared community space. Yet, education researchers have largely dismissed the role of community of practice in the informal learning of members of such spaces (Kera, 2014; Kolko et al., 2012; Raison, 2010). Here I argue that the mentioned authors did not go deep enough into the fundamental structure of communities of practices, including how they manifest within such creative contemporary spaces as makerspaces and hackerspaces. Here I present a detailed analysis of Technarium – a hackerspace in Vilnius, Lithuania – as a community of practice, first establishing why this model fits the selected space so well, and second by providing cases of informal science and technology learning happening, as enabled within the community.

4.1.Methods

Selection of research object: Technarium

Technarium was selected as 1) the only hackerspace in Lithuania; 2) a community place with strong attitudes towards science and public education of science and technology. The purpose of the study was to find out the "what" and "how" learning occurs in a hackerspace community, as the phenomenon has been largely unexplored. Therefore, the study of Technarium, as a case of such a phenomenon, was selected as fitting. (Baxter & Jack, 2008)

Ethnographic approach

The ethnographic approach, based on observations and interaction within the community of practice at Technarium, was selected for several reasons: 1) the suitability of such an approach to uncover unique bodies of knowledge and

knowledge transmission in the community; 2) the ability to analyze diverse artifacts, as well as physical products, in the dynamics of the community and knowledge transmission; 3) the suitability to analyze face-to-face communication as it occurs naturally within the community, as well as identifying interpersonal ties and dynamics; 4) the ability to identify communication and language elements, unique to the hackerspace; 5) the suitability of exploring the full scope of a heterogeneous community structure in the hackerspace; 6) the ability to study the community while being a functional part of it myself. (Lorenz & Barlatier, 2007)

Enabled by the ethnographic approach, the prolonged observation and being a part of the community myself, has allowed me to uncover rich knowledge about community dynamics inaccessible to a visitor, and reveal its links to knowledge transmission in various topics within the hackerspace.

Data Collection

I collected data on Technarium community and activities via field observations and interviews from October 2015 to May 2016, spending several hours in the hackerspace each week, and attending the main events. Prior and during that time I conducted analyses of Web-based archives, such as blog postings, online community discussions, mailing list messages and documentation.

Interviews were conducted in an unstructured or semi-structured format, often initiated by me, but then led by the interviewees. Observations included noting community dynamics and learning cases in everyday activities and events, analysis of artifacts and the living history of the hackerspace.

Quotes from interviews and observations are presented in italics in this work, and numbered in numerical order. Due to the diverse contexts that

different quotes were acquired, they are not assigned to a particular member. Original quotes in Lithuanian are presented in APPENDIX III.

Data Analysis

Our analysis was ongoing, and throughout data collection we transcribed interviews and video observations, created case summary sheets, and wrote analytic memos.

During ongoing analysis, the interviews were transcribed, event and general observation summaries were produced. The final interpretation of the data was discussed with two core members of Technarium to ensure alignment with their views as well. Core members also provided a fact check of the basic features of the space (such as the current size, equipment, number of members etc.).

4.2.Technarium as a community of practice: observation analyses

According to Wenger (1998), "Whatever it takes to make mutual engagement possible is an essential component of any practice" (p. 74). While this is a rather broad statement, in a place such a hackerspace, the conditions for successful mutual engagement quickly begin to take shape, although some may be more obvious than others. These conditions are summarized in Table 2. However, to understand how Technarium functions as a community, is it important to discuss all of them in detail, including the history of how the place came about and evolved.

Table 2. Summary of conditions that make mutual engagement in Technarium possible.

PHYSICAL SPACE	Based in a 1000 m^2 space, which contains: metal workshop, wood workshop, electronics and 3d printing lab, biohacking lab, ceramics studio, sewing studio, cnc construction area, uav/drone construction area, photolab, common kitchen, brewery in-the-making, lounge; there is also a recently added storage/painting area & workspace of cinema decorations' studio, which includes a cnc/laser cutting room.
PEOPLE	~80 regular members[12], as well as a dozen or so regular event-goers who do not have an official membership, but appear in weekly and/or monthly meetings. Core members have been involved in the creation of the hackerspace, and most have participated in creative work together before Technarium was established. Among the core and other full members there is a range of expertise, including science (physics, including biophysics, laser physics and astrophysics, biochemistry, mathematics) and technology disciplines (electronics, hardware engineering etc.).
COMMUNICATION	Members have a unique language, which manifests both in technical terms, and the manner and slang of a particular subculture (dominated by laid-back, punk rock and DIY). New members may have a problem in communicating with the full members; however the oldtimers are generally good at facilitating communication.
ETHICS , VALUES & RULES	According to the core members, the hackerspace formed & is functioning in context of "classic hacker ethics" as described in Himanen (2001), namely: passion, freedom, social value, openness, activity, caring and creativity. Membership entails accepting the membership agreement, as well as understanding the general rules of membership (APPENDIX I), including the restrictions to use of equipment, such as the need of training by an experienced user. There are also unspoken rules, such as the free knowledge sharing, expectation to help with the building & maintenance of the physical space etc.
SHARED REPERTOIRE	Includes equipment, shared products, events, and other cultural elements & artifacts, such as jokes and memes, stories etc. Equipment. Metal workshop: welders, lathe, drill press, grinders, saws, plasma cutter, other hand-held tools; wood workshop: compound sliding miter saw, lathe (large and small), hand-held router x2, a variety of hand-held tools; electronics: oscilloscopes, signal generator, multiple soldering stations, hot air reflow station, bench-top power supply, multimeters, reflow oven, ultrasound cleaning bath; ceramics studio: two electronically controlled kilns; two sewing machines in sewing area; biohacking

12 As of May 25, 2016.

	lab: multiple microscopes, incubator, shaking incubator, lab ware, chemicals & molecular biology reagents, centrifuge, PCR & electrophoresis machines under constructions; there is also two 3D printers, a CNC cutting machine, a laser cutter under construction, other minor tools. Events: Artifacts & past projects: Technarium name and logo; products created by ad-hoc groups within the hackerspace, including commercially available products: *Chirp* plant watering sensor[13], part of engineering and assembly of *TableAir* smart desk system[14], micro hydroelectricity plant[15], smart greenhouse prototype [16], others, many of which are open source hardware and software[17], arts installations that end up in Technarium after events, such as the "Microscope"[18] installation made for Culture Night (culture festival in Lithuania); photos and artifacts from various events, some of which carry a special meaning (see below); jokes & memes that are displayed in the common areas of the hackerspace and travel throughout the community. Events: weekly Electronics Monday[19] & Erlang meetup[20]; monthly members meeting and Hack & Tell[21]); irregular social evenings and other meetups; external events such as faires, conferences, festivals and hackathons.

13 http://wemakethings.net/chirp
14 http://tableair.com/
15 http://blog.technariumas.lt/post/124601966356/diy-hydroelectricity-connecting-a-generator-to-a
16 https://github.com/Technariumas/opengreenhouse/

17 Source codes provided at https://github.com/Technariumas/;
18 http://blog.technariumas.lt/post/122335418856/microscope-installation-live-at-culture-night
19 http://blog.technariumas.lt/post/144447018571/electronics-monday-tonight
20 http://blog.technariumas.lt/post/142697448231/live-coding-on-the-wall-at-the-erlang-meetup
21 http://www.meetup.com/vilnius-hack-and-tell/

4.2.1. Physical space

The unique quality that distinguish a hackerspace or a makerspace from just any case of making and hacking as a hobby is having a joint space for the members to work in. Importantly, the community dimension is already encoded in the existence of a physical hackerspace, as this is intrinsically a place to meet, work together, exchange knowledge etc. In fact, the initial creation of a joint space was both the result and the condition for a group of like-minded builders and tinkerers working together. According to one of the members, who has been involved with the hackerspace from the very beginning:

Technarium grew from a group of friends, many of which grew up with parents who had one or another type of workshop. We also were and remain to be associated with punk rock and DIY subcultures, therefore for a long time, ever since I can remember myself, we were doing something: silkscreening, electronics experiments, furniture for own use…

Eventually we settled into the basement of one underground club in Vilnius, set up a workshop – in principle we just had electronics and some other tools. (Q1)

Therefore the need to acquire a physical workshop space came primarily from the existent community of like-minded individuals who were already spending time together as part of the mentioned subculture, and working on similar small scale projects. Of interest is also the way the interviewee describes the formation of the hackerspace as *growing*, i.e. coming into being, in response to the needs of an existing group of friends, emphasizing that the hackerspace formed organically, as opposed to being set up with a pre-specified agenda in place, as some commercialized makerspaces[22] are. The physical space was therefore a natural extension to the existing practice in the group.

[22] For example Green Garage in Vilnius, http://greengarage.me

The interviewee also describes how the place soon grew in size in response to the growing community's needs:

Some people had been working with theater technicians – were making decorations and other technical solution, lights for them. When we started to lack space in the workshop – which had space for 5 people working on top of each other no less – we moved to hangar in a former drill factory. There was loads of space there, [but it was] cold, wet, unwelcoming… However, we could carry out larger projects there. (Q2)

Importantly, even though the space is described as "unwelcoming" from the most obvious perspective, i.e. being cold and wet, this was still a space that was worth for the community to keep, since it was well-suited to carry out their projects. This is in line with some aspects of the hacker ethics, which suggest that the basic survival needs might be minimal for a hacker, and she or he can work for "days on end", providing they find enjoyment in their work (Himanen, 2001). This seems relevant also to the attitude of the community in the beginning of Technarium.

A couple of years later, the hangar was bought by a real estate company, and the group moved to the current location. The evolution that followed also took place in response to the needs of the community. I.e. in the beginning, the space only occupied the ground floor of the building at Aguonu str. 17 (~400 m^2), dedicated mostly to metal works and wood works. In a few months the group decided to rent out a space on the first floor of the building (~300 m^2 more), with space for a lounge, electronics lab, ceramics studio, and biohacking lab. The extra space was rented out in May 2015, after a call out[23] to another group of Vilnius hackers (hackerspace.lt at that time) who shared the interest to have a more full-rounded hackerspace. A few other activities appeared at the space a little

[23] https://groups.google.com/forum/#!topic/parallax-manufactory/nSfdxWe5NTo

later too, including a sewing area and a brewery which was still in-the-making as of the time of writing. The latest extension (February 2016) has been renting out a large hall on the first floor (~100 m^2), which was decided in collaboration with a local small company that makes cinema decorations, which needed a new place for their workshop. It was first decided to adjoin their workshop to Technarium by adding the extra hall, and so extending the space and the community. However, it was quickly decided that instead of just attaching an extra hall limited to the new members' needs, it would be better to reorganize the entire hackerspace such that the activities and tools would blend in with the existing ones. All members of the hackerspace were invited to participate in the discussion by one of the core members via the mailing list:

Today some new people are joining us, and [are doing so] together with us. (…) Now the main question is: how do we and they want to be together? Perhaps we should reorganize the existing area and optimize spaces? (…) I invite everyone to come to meet, and participate in the thinking of how we should be together and improve the usability of spaces, share your opinions, and gather to discuss, to come up with where, how and what would be fun for everyone to put and create? (Q3)

Therefore the decision to extend the space was made in response to growing community's needs, and was not made so in isolation – instead the entire group of members where consulted and, in fact, later participated in the reorganization of the physical space. This also ensured that the new people did not work in isolation even though they already had most of the tools that they needed, but became a live part of the community and space as a whole.

In regards to "physical space", it is also important to mention that this term has a multidimensional meaning embedded in the deeper culture of

Technarium that has been part of the hackerspace since before its establishment. According to one of the core members[24], as citizens in the Informational Age:

(...) we spend most of our working life in the world of abstractions. We build crystal castles in the air and sometimes lose touch with the physicality of the medium other than pure thought. (Q4)

This, another member explains[25], is the main reason for having a "physical" space for hacking:

Why did we need a physical space in the digital age? Because we are still real people after all, we were interested in real physical things, not just software. You know, as a programmer I can tell you – it's a real big thing to make something with your own hands, something that you can show to your mom. (Q5)

Therefore Technarium has a multitude of equipment and tools:

This is why we embrace the analogue [real-world] crafts and technologies – ceramics, jewelry, metal casting, sewing – at Technarium: they are, of course, influenced and improved by the new, digital, technologies. But they also let one stay in touch with the matter they work with. (Q6)

This is an important defining factor of the Technarium hackerspace, which distinguishes it from some of the other types of hackerspaces and hacker gatherings, e.g. ones focusing merely on programming or limited to electronics etc. Technarium attitude is to stay in touch with any media (see also "Ethics & values") and let the interests of new members shape the direction of the hackerspace activities. It also helps to emphasize the *domain* of the community of practice as one of making physical things that matter, which serves an important role in the process of learning, i.e. legitimate peripheral participation (see section 2.2 Learning and identity).

[24] https://technariumas.lt/BuildStuff2015.html
[25] https://technariumas.lt/WhatsNext2015.html

Another important feature of the space is its shared nature and relatively low barriers between different areas (see Figure 2. Architectural plan of the shared space in Technarium (first floor). (Ground floor where metalworks and woodworks are located are not shown.) The plans serves to demonstrate the overlapping, and walk through nature of the different areas. The only areas separated by a wall from the rest are brewery, biolab and electronics/3D printing/programming room. Source: Technarium archives.), which serve to facilitate casual sharing of expertise between members, often so just by casually passing by one area or another.

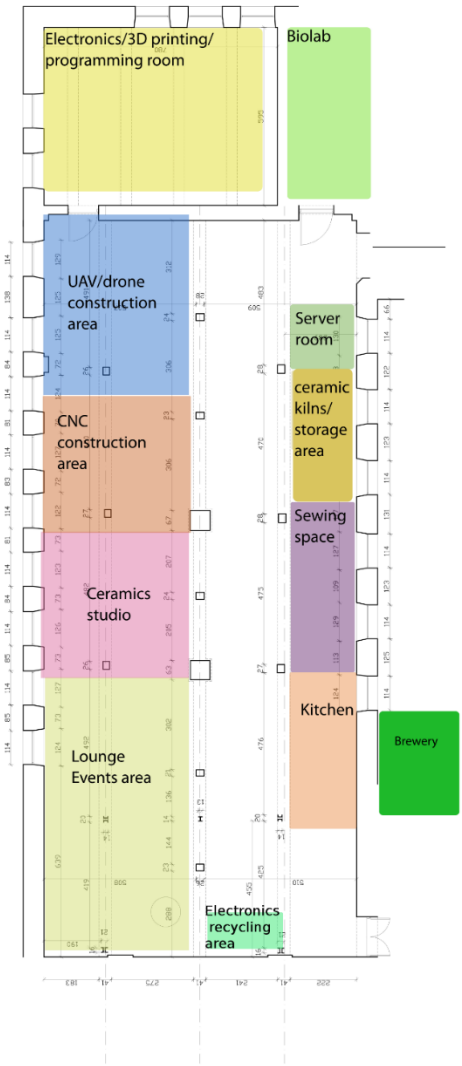


Figure 2. Architectural plan of the shared space in Technarium (first floor). (Ground floor where metalworks and woodworks are located are not shown.) The plans serves to demonstrate the overlapping, and walk through nature of the different areas. The only areas separated by a wall from the rest are brewery, biolab and electronics/3D printing/programming room. Source: Technarium archives.

4.2.2. People

The absolute condition for the continued survival of the community of practice and learning via mutual engagement, is a network of people, who continue to interact on a regular basis, i.e. the *community* itself. At the time of this writing, Technarium has around 80 official members, i.e. those who have signed the membership agreement and are expected to pay a monthly membership fee. However, the community of Technarium does not end there, as there is a proportion of people who only come to regular events (e.g. Electronics Monday[26], Hack & Tell[27]), sporadic workshops (e.g., *Make a Chirp!* electronics workshop[28]) and then continue to stay in touch, as well as people who have signed up for the general Technarium mailing list[29] to stay in the loop with various events and activities of the community.

According to one of the core members, there are several main types of motivation for people joining the hackerspace, including those who have a "clear creative vision and know exactly what and how they want to achieve, even if not technically, but they know what equipment they might need and what would they like to learn". These people, according to the interviewee, "do not get discouraged by the fact that the place is dirty and not prepared [for the specific work]". There are also people who just want to use the equipment and have a place to work; and those who want to go deeper into a specific topic, such as electronics. These are all besides the core participants who have been involved in the creation of Technarium since its beginning, as well as outsiders who show interest in the space during events, exhibitions, visit as potential sponsors etc. E.g. one of such

[26] http://blog.technariumas.lt/post/144447018571/electronics-monday-tonight
[27] http://www.meetup.com/vilnius-hack-and-tell/
[28] http://blog.technariumas.lt/post/132163648756/make-a-chirp-electronics-workshop
[29] technariumas@lists.technariumas.lt

cases has recently been the visit of Vilnius Mayor to the hackerspace[30], which is likely a beginning of collaboration with the city council.

Members' observations and accounts of the hackerspace suggest four main types of participation within the hackerspace, as well as outsiders who in one way or another may influence the hackerspace community and/or enter the periphery of the community at some point. These are represented in Table 3 below:

Table 3. Types of participation in Technarium, including main four types within the hackerspace, and outsiders. The column on the left represents how these largely correspond to full /peripheral participation proposed by (Wenger, 1998).

Core participants	4-5 people involved in the creation of Technarium from the very beginning, and to this day maintaining the most active roles in community maintenance, representation etc.	*Full participation*
Active participants	Members actively involved with Technarium for a significant time (even though that may vary for each person), but, more importantly, grasped the key language, ethics & philosophy of the hackerspace, appreciative of its history and shared repertoire, taking up active roles, organizing events etc.	
Sporadic participants & event goers	All official members and regular event goers who are engaged in one or another activity at Technarium, but doing so only sporadically (such as when they have a specific project to carry out), accept the rules, enjoy the atmosphere and share the ideas of other Technarium members, are receptive to the learning opportunities that the place offers	*Peripheral participation*
Peripheral participants	Those who do not have official ties with the hackerspace (i.e. membership agreement), however are interested in one or another aspect of its activities and follow the general news of Technarium (such as via the mailing list or blog).	

[30] http://blog.technariumas.lt/post/142688765321/mayor-of-vilnius-visits-technarium

Outsiders	Interested guests, event audience, potential sponsors, who are not in any way participants in the community of practice itself, but could be influential to its existence (e.g. by sponsoring or providing audience/market for specific things or events), and has also the potential of becoming members.	*Outside*

In regards to the general idea of learning in a community of practice as the conversion from peripheral to full participant in the community, it is useful to notice that core and most of the active members could be considered "full participants", and sporadic & peripheral participants as "legitimate peripheral participants". According to Lave & Wenger (1991) it is the transformation of legitimate peripheral participants that constitutes learning in a community of practice, i.e. acquiring the cultural competence to function successfully in the community. That also makes a participant more likely to share and receive information that lead to particular cases of informal learning, such as of science and technological topics, which are prominent in Technarium (see sections 4.3.1 and 4.3.3).

Importantly, the types of participation that have been described by the interview members of Technarium, and emerged from continuous observation of the space, fit strikingly well with the model proposed by (Wenger, 1998) (Figure 3). These categories are useful in analyzing the learning processes as they occur within the hackerspace.

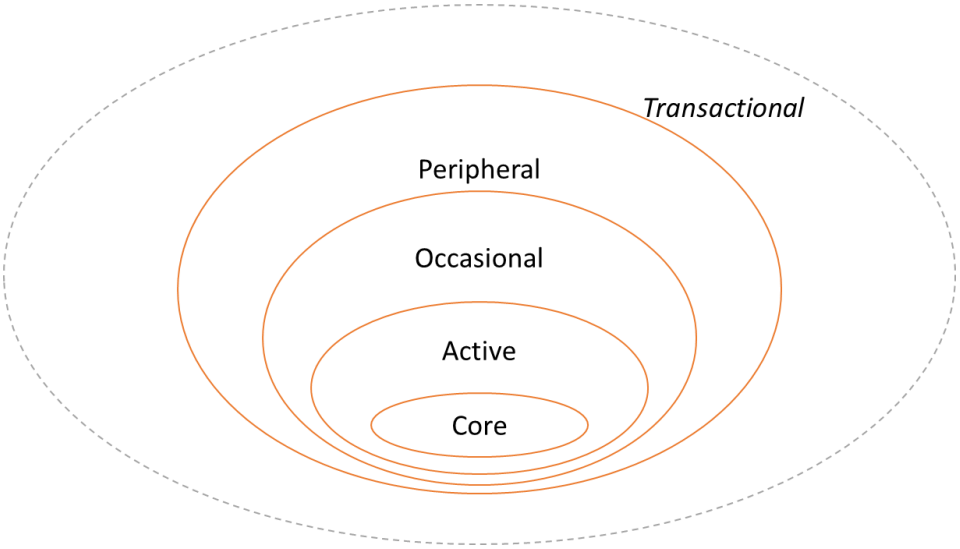


Figure 3. The levels of participation in a community of practice, adapted from Wenger (1998) and Wenger-Trainer.com[31].

Due to the decentralized and heterogeneous nature of the communities of practice, it would be impractical to represent this member make up by either a pyramid, a radiogram or a similar method. Instead, it is important to realize that once a participant enter the community, i.e. becomes a legitimate peripheral participant, she continues to interact with other peripheral participants, as well as the core members. Both can operate as transmitters of language, knowledge and skills to become a full participant, however, core participant tend to do that more actively. I therefore argue that the best way to represent the different types of participation in Technarium is by more lateral schematic as demonstrated in Figure 4.

[31] http://wenger-trayner.com/project/levels-of-participation/

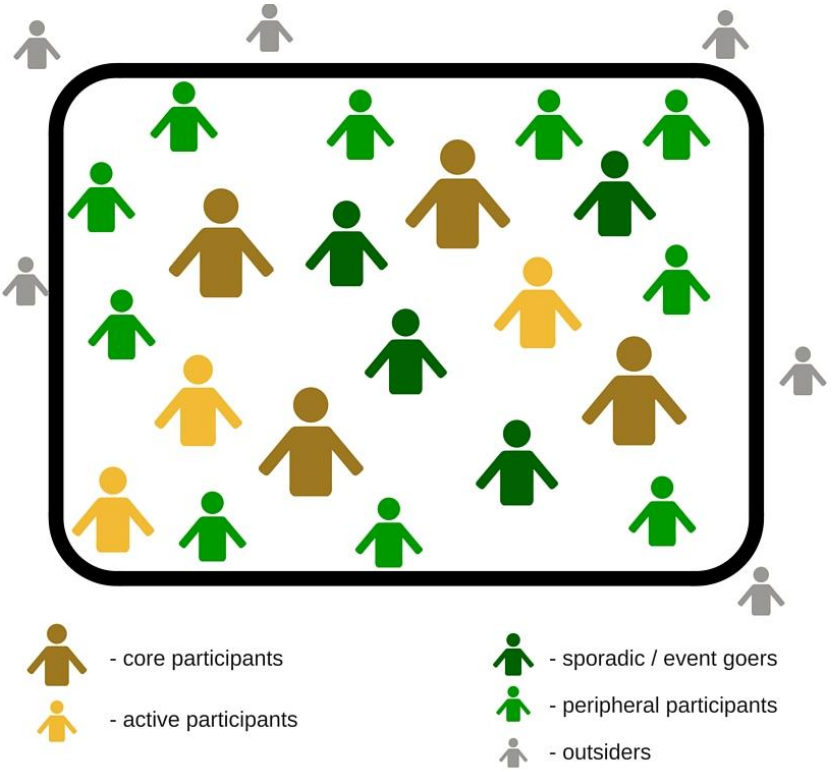


Figure 4. The different types of participation at Technarium (Table 3. Types of participation in Technarium, including main four types within the hackerspace, and outsiders. The column on the left represents how these largely correspond to full /peripheral participation proposed by *(Wenger, 1998)*.), as they interact within the community. Even though different members may have more experience in the community, this does not result in formation of "clubs" or any other way of isolation from other members. In particular, the communication between oldtimers and new members, is essential to ensure learning, as well as reshaping of the community's "regime of competence".

It is important to remember that the community of practice is never a constant or homogenous structure, and the potential to learn always depends on the expertise, experience and expectations of the existing members, the makeup of which is changing in the hackerspace over time, and so do opportunities for learning. However, the core members seem to maintain the highest influence on

the general attitude of Technarium as a community, and how it is realized via community interactions, meetings, events etc.

4.2.3. Communication

The initiation of new members, sometimes even before they sign the official membership agreements, starts with an email sent by one of the core members to the entire members' mailing list at Technarium and titled "New members". The email acknowledges the people who had just joined by name, and containing a list of information, most of which concerns the question of internal hackerspace communication. To illustrate the main idea and content of the email, below is its basic structure (original letter in Lithuanian can be found in APPENDIX II):

P1	*Welcome to particular members*
P2	*Text: "Some info:"*
P3	*Info & contact details concerning electronics lab, 3D printing, metal works, equipment use restrictions & training schedule.*
P4	*Info and time for the weekly electronics workshop, which is a "non-formal gathering to ask questions, carry out an experiment, burn or measure something"*
P5	*Info and time for the monthly members' meeting where "we discuss current questions & pitch in for the next month's rent"*
P6	*Info and time for weekly Erlang meetup; mention of sporadic events that sometimes happen and link to Technarium meetup group*[32].
P7	*Info and details about paying for membership.*

[32] http://www.meetup.com/Technarium

P8	*Links to blog, wiki, file cloud (providing user & password), Twitter account, Github account, Hackaday account, project archive.*
P9	*Links to mailing lists ([members], [technariumas], [crew]) and explanation of how to configure personal email accounts in order not to miss any of these emails.*
P10	*Encouragement to send photos/descriptions/code of all the projects that the members are taking on for the blog, "regardless whether it is a fail, an experiment, a prototype, or just a part of the process, a serious project or a broken tool, or a built working place. ;)"*
P11	*"We'll see you, probably, in the workshop"*

While this might seem like a casual email that older members have seen times and times again (and probably start ignoring it quite soon), this serves as an important initiation for the *new* members, as it provides links to both physical and virtual modes of communication, which are used interchangeably in the hackerspace. Most importantly, it ensures new members have a way to enter & interact successfully with the *community*.

The main modes of communication then continue to be the regular events for those who attend them, particularly the monthly member's meeting, as well as the social evening that is organized sporadically. Other events gather specific parts of the community, such as those interested in electronics. Importantly though, due to the nature of the joint spaces, and few things that separate one area from the others, members have a tendency to stumble on each other's activities while simply walking by and engaging in casual conversation with someone working in a different part of the hackerspace. For example, in a recent microscopy workshop, someone walking by from the electronics lab to the kitchen stumbled upon the microscopy activities and came to look at some samples; that started a technical discussion about how light in one of the

microscopes works (see more in section 4.3.3). This ensures that communication continues between people of different skills, knowledge and expertise (see section 4.3.2).

However, besides the highly technical level of info one needs to get to be able to participate fully, is the meta-dimension of communication, which includes the ability to understand and converse in the specific language that full (and especially core) members use. According to Lave & Wenger (1991) successful communities of practice are those where "coherent, meaningful participation in activity is possible" (p. 77-78). As later elaborated by Wenger (1998), that includes all the conditions that make participation in a particular community of practice possible, such as learning of ways and language (slang, sense of humor etc.) of a street gang to be a functional member of that gang. This way the language is fundamentally linked to identity, i.e. to identify with the community one needs to pick up the specific ways that other full members in communicate in. This dynamic is also very obvious in the hackerspace.

As the core members, i.e. creators of Technarium, seem to the most active in the community to this day, their language is one that serves as basis for the "regime of competence". Curiously, this is linked partially to the initial subcultures they trace themselves to, including the punk rock subculture. Examples include not-so-harmful swearing, laid-back attitude, heated language surrounding conforming to rules and laws that can sound alarming to newcomers, etc. Importantly however, the core members themselves are very tolerant to other subcultures and other types of communication, which they state publicly. One core member stated in a radio interview that even though they started from the puck rock and DIY subcultures:

In short, punk rock pants are too small for us already. (Q7)

Other types of specific language used is technical slang, such as casual terms for people, tools and processes in various trades, including metal works, electronics etc.; programming terms that are used casually due to a high proportion of people who are in one or another way involved in programming; technical and hacker terms that might be completely unfamiliar to newcomers (see Figure 5), and so on. Moreover, the core members have a habit of using nicknames instead of real names of members, which can become very confusing to newcomers, since the words do not carry any specific meaning (some of these nicknames are just 3-4 letters long and do not resemble real words at all, e.g. *opit* or *mic*), and cannot be associated with the person until researching all the names and nicknames of the hackerspace members. This is also one of the key features that seem to demonstrate how a newcomer is becoming more proficient in inter-hackerspace communication, as eventually they pick up the same habit and start naming people naturally by nicknames.

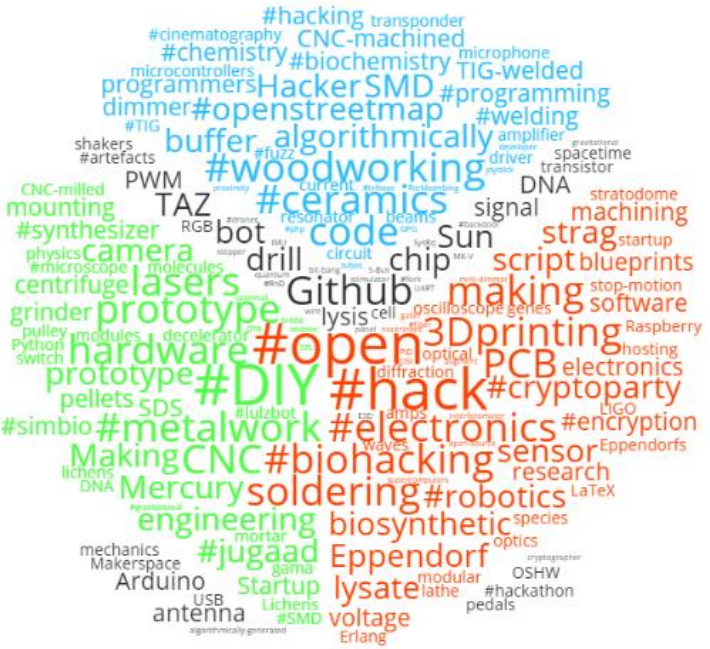


Figure 5. Hackerspace specific terms used in Technarium blog since 29th October 2015. Some are technical terms specific to a particular domain (e.g. biohacking, electronics, astrophysics etc.), some are more general hacker terms

Importantly, the use of this specific language comes very naturally to the full members, which is both a strong and fascinating manifestation of their identity and "regime of competence" of the community of practice, but could also be discouraging to newcomers who do not identify with that language. This is also where misunderstandings and awkwardness often happens, examples of which include a peripheral participant feeling unwelcome and excluded by the other community members until one core member dispelled these fears by adopting a very clear and common discourse in a meeting; miscommunication about organizing events, including one member feeling frustrated that the other members do not seem to take her upcoming event seriously, which later turned out not to be the case etc.

As in any community, some members have more essential communicative skills than others. I propose to call them the "bridge-makers" and suggest that their role is fundamental in connecting different members of the community. These members can speak both the language of full and peripheral/guest participants, and know well which one to adopt when speaking to specific members. Moreover, other than simply "translating" between the two languages, these members also encourage active sharing of information, and collaboration between different members, that they see would benefit both parties and/or the hackerspace.

4.2.4. Ethics & values

According to the members themselves, the ethics with which in mind the hackerspace was built, is based largely on "The Hacker Ethic" proposed by Himanen (2001):

The motivation behind creating Technarium was very simple and natural. Simply the desire to create a community of people who would be

interesting to work with and spend time with (...). In principle, this is the hacker ethic, if you've read that book by Himanen: desire to create, act, share and that you care about what's happening in the society. (Q8)

Another member describes the "hacker motivation" that they follow in for words – "Act, Create, Care, Share" ("Hacker ethic" – presentation at *What's Next?* Conference, 2015[33]). To start with, acting, according to him, can be very easy, and yet difficult to carry out:

Often in Lithuania we hear (I want to say "used to hear") how nobody can never do anything. Cannot do it because of this, of that, because they don't have something, because they don't know how, because they don't know who to ask permission.

*A hacker can. Hacker does not ask for permission. Hacker learns. Hacker goes where she has not been before. Seems like a simple thing, but often difficult to achieve. You just place yourself into a position of which you can. You can and you do. Whoever hasn't tried this – I recommend it, it's a very liberating experienc*e. (Q8)

Creating, in his opinion is almost a magical feeling:

It's probably the most motivating factor. You know, that feeling when there's nothing, and then you take actual, and voila – there's something. There's something godly in that, that feeling that you can multiply things in the world is catchy and exhilarating. It's almost addictive (...). (Q9)

The aptitude for building and creating their own things is, of course, the definition of the hackerspace itself, and many members work every day on leisure and/or commercial or freelancing projects. Moreover, this seems to give most members great joy. For example, in a discussion that emerged during one meeting concerning buying vs. building surfaces for the kitchen in the

[33] https://technariumas.lt/WhatsNext2015.html

hackerspace, one member said firmly: "No one counts time in the workshop![34]" (laughing). Importantly, this was not accepted very well by the guests in the meeting at the time, who, incidentally, never came back to the hackerspace.

Caring, in turn, is an essential part of any hacker ethic, and is emphasized so by the members of Technarium:

Creations are more effective when they are relevant not only to their creator. Hacker takes care of the environment he is active in, because it is simply more pleasant to be active in a nice environment. Hacker cares that her creations are meaningful to other people, and cares that people get educated to the level of being able to use her creations. (Q10)

The issue of "caring" might apply more to some members than other in the hackerspace; however, it is definitely shared by the core participants. According to one of them:

We care more about things that actually matter for the world. (…)

We noticed that many things that are produced by self-identified makers, or even people who create open source electronics (…), are in principle just for fun. (…) Which is OK, fun and games. But you know the story of open source software? It now rules the world (…).

However, in the physical world things that are used every day are either very expensive or very low quality.

(…) eventually we realized that there are simply not enough useful, open, good quality building blocks for most things – mainly electronics, such as control systems, sensors, power sources etc. (Q11)

[34] Modification of a Lithuanian saying "laimingi laiko neskaičiuoja", meaning "happy people do not count time".

In response to this, Technarium hackers have since produced various hardware, e.g. a solid-state relay[35], a temperature controller that is used in the ceramics kilns at the hackerspace, and is also being adapted for an open source crematorium in the Netherlands[36], etc. Interestingly, this also serves as one of the defining factors that separate Technarium from makerspaces that may value just hobbyist activities and spend little time in coming up with projects that are useful for someone else beyond themselves, or even the society as a whole.

The next of the four key values, sharing, is also prominent in the hackerspace. In fact, making sure that talented people do not work in isolation and instead share knowledge was one of the main primary motivations in creating Technarium. According to one of the core members:

This is a problem of Lithuania or post-Soviet countries: many people are crafting something, tinkering with something, being interested in something, there's many smart, educated people, but they sit in solitude in the garages and little rooms and don't share, don't see what others are doing.

One member came once and told us (he was engaged in tinkering, electronics, plane crafting for a long time) that nobody has ever understood him, neither girlfriends nor family, but he came to us and accidentally realized that there's a full house of people just like him!

Eventually we saw that people "need" this, since there was always someone coming by to make something, or for a consultation, or ask us something. (Q12)

Open source is one of the main values in the hackerspace, and members are encouraged to license their projects accordingly. Knowledge sharing within the hackerspace is also one of the unspoken rules. Interestingly, even

[35] http://wemakethings.net/2013/10/27/triac-bloc/
[36] http://pyrolysium.org/

though most seem to accept this rule, some members suggested to reinforce it in the official rules of the hackerspace adding a line: *"Advice should be free, as long as the competent person has time for it."* However, the suggestion was shot down with an explanation that "this is the goal and the whole point" of being in a hackerspace. Similarly, the same issue was put forward by a relatively new member of the hackerspace who was uncomfortable about wasting the time of other members "to teach him". This was again explained by one of the core members as "the main point – to help each other, as much as you can, e.g. some members organize monthly metal training etc."

The intrinsic right of any member to reject the request for advice was discussed in making the rules as well, which, curiously enough, has recently become very relevant in context of various startups and outsiders with ideas coming to claim the expertise and time of Technarium members for free. This is why the members recently introduced an informal consulting meeting, jokingly called "Brickwall Startup Decelerator" (Figure 6), which deals the same with all such requests, only allowing consultations on Friday afternoon, providing the requester brings pizza and does not take too much of the member's time. Regardless, the general attitude of free knowledge sharing within the community remains the same, which is, as previously explained, one of the success factors in the community of practice.

Another important value to highlight is the existence of the community itself. While the hackerspace collects member fees (and, therefore, is not completely open and free for anyone to come in), it is 1) the sole source of income & resource to pay for rent, maintenance, tools etc.; 2) a way to foster the community by encouraging *mutual accountability*, rather than creating a barrier to entry.

Figure 6. A CNC-engraved sign of the Brickwall Startup Decelerator, made by several members and displayed during a recent Login Startup Fair. The design and name, according to the members, is a play on often overhyped belief in startups and unfounded optimism inherent in the startup culture.

The problem of members not paying their fees has surfaced recently (in response to high electricity bills during the winter), and in addition to being a financial issue in and of itself, it has caused intense discussion among members about the place introducing bureaucracy and being not entirely open and free, as voiced by several members. However, when asked about it, one of the core members responded:

I wish that people would commit to the place, commit to each other, [commit] that I will be here and I will see you around here. This is not a way to commercialize or formalize the place, but it is a commitment. (Q13)

In a discussion that followed, the same member also voiced his discontent with people who only come to carry out one-off projects, while another suggested this is valuable for the hackerspace commercially:

> - *It's better than if they don't come at all, but of course it is better if they come regularly, and commit, and maintain the place.*
> - *But it is important that these people come and provide significant income from the projects that they do here.*
> - *No, this is exactly the opposite to what we are trying to do – we are not a commercial place, like some other spaces, like Green Garage*[37]*, for example.* (dialogue)

The same attitude of maintaining a community above any other goal has been shared by other members in interviews as well:

Sometimes people simply come with one-off projects, complete them and disappear. (pause) Of course, this is not good practice, we are keen to have more regular people, because that is how this fellowship *[emphasis added – EMR] expands.* (Q14)

People who only need advice and help with one thing, they usually don't stay and don't contribute to the community, they make what they need and disappear.

There are also a few people who simply like the idea [of the hackerspace], like the opportunity to come and do something, and they simply pitch in for the rent, even though they are not doing too much of anything right now. (Q15)

In fact, this is precisely the reason why a specific type of membership, the "Starving hacker – 10€" has been set up, to support all those who

[37] http://greengarage.me/

would like to contribute to the maintenance of the community, but may not be especially active in the hackerspace at any one time.

Another characteristic statement about the importance of the Technarium community has also been publicly made by one of the members during an exhibit, while asked "where is it that you work", answered:

Well, how to tell you… we don't work here, we are *Technarium.* (Q16)

This is particularly meaningful in a sense that many core members of the hackerspace, including the one who made this statement, actually are freelancers who *do their work* and earn their living in Technarium. Regardless, they by no means see Technarium just as a place to work – they feel they *are* part of the Technarium community instead.

This attitude of members is consistent with the community of practice notion of *mutual accountability* proposed by Lave & Wenger (1991), Wenger (1998) and later works. This is, in fact, one of the factors that makes the community of practice work, and hence improves the opportunities for learning and excelling in the community.

Interestingly though, the community did not actively associate themselves with a "hackerspace" as such in the very beginning of their existence. Instead, the thought of "creating a hackerspace" entered their minds some years after, by realizing the abundance of such spaces in the world, and the fact there are no such spaces in Lithuania, even though "people need them". In autumn 2013, the group came up with a name "Technarium", settled on calling the place a "hackerspace", and started to promote the place to the public and carry out public events". Therefore, the space formed organically, and the decision to call it a "hackerspace" rather than anything else, came from the intrinsic hacker ethic already embedded in the current group of friends. This point is particularly

relevant to the fact that communities of practice, even though useful to foster learning in various environments, such as working places, technical creator spaces etc., cannot be prescribed (Wenger, 2010), and are unlikely to evolve and function in anything other than natural conditions.

4.2.5. Shared repertoire

The ability to share equipment and tools is one of the fundamental elements that make mutual engagement in any hackerspace possible. Moreover, this sharing of equipment is also the source of learning in certain situations (see section 4.3.1). Shared equipment, is, of course, precisely the advantage that a hackerspace has over an isolated workshop, both by increasing the capabilities for different projects (i.e. it is easier to purchase or build a 3D printer if many people pitch in rather than alone), and creating opportunities for combining of expertise and thus learning from each other. Interestingly, the need and maintenance of equipment is also a subject of negotiation within the community, i.e. there is no centralized body that decided what to buy, or when and how to maintain it. Rather, these things are discussed and decided in the monthly meetings and via the mailing lists.

The next dimension of the shared repertoire is events. Events are important in a sense that they actively gather community members together at weekly and monthly intervals, as well as sporadically. This is very important to maintain effective mutual engagement, since other than that most people may meet only rarely in the hackerspace – after all they all work at different times, use different areas and so on.

Events tend to gather members of specific interests and/or roles together. With the exception of the monthly members' meeting, Hack & Tell and irregular social events, specific workshops gather people with interest in

electronics (e.g. Electronics Monday), programming (e.g. Erlang meetup) etc. There are also external events, such as a recent LOGIN Startup Faire[38], Vilnius Maker Faire[39], various conferences etc. The external events tend to serve a representative function are mostly carried out by the core members of Technarium, and are often a way to recruit new members or attract the interest of various outsiders of the community (such as sponsors).

Hack & Tell is a particularly important event from the perspective of knowledge sharing, as it gathers makers and hackers from within and outside the hackerspace, and encourages them to show whatever they have been making, and explain how it was made in detail. The homepage of Technarium states that Hack & Tell is "a geek party where everyone can present their projects, ask for an advice, meet like-minded people". According to one of the core members, Vilnius Hack & Tell "are one of the best (I used to go to them in Berlin), because they are orientated not only towards programmers, but people come with various projects, from a baked cake to a smart house".

Joint products are, of course, some of the more profound artifacts in the community. As mentioned in Table 2. Summary of conditions that make mutual engagement in Technarium possible., these include products like *Chirp!*, hydroelectricity plant, Open Greenhouse and other products that have been made by ad-hoc groups in the community, but, importantly, are acknowledged and appreciated by most members of Technarium and constitute an important part of the community's history. A key disseminator of this information is the blog, where each such project, as well as its developmental process, is readily shared. Past

[38] http://blog.technariumas.lt/post/143846094281/tomorrow-hardware-district-at-login-startup, http://blog.technariumas.lt/post/143889925541/technarium-biolab-at-login
[39] http://www.makerfairevilnius.com/en/dalyviai-3/

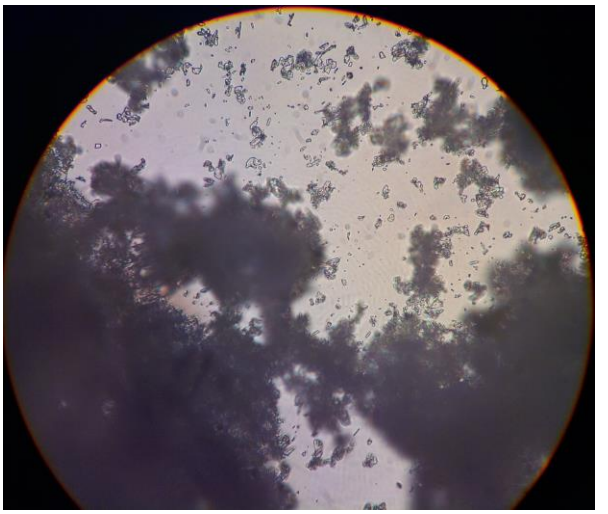
products of Technarium are also featured in faires and exhibitions to help represent the hackerspace.

The more casual, but nevertheless key to the maintenance of the community are jokes, anecdotes and memes that are travelling around the community, and illustrate the general attitude and values of the community very well. Occasionally, these artifacts have themselves become the objects of learning in the hackerspace. Some of the more curious examples are described in Box 1 and Box.2

Box 1. Abandoned spaghetti: traveling joke

Two members had boiled spaghetti in the new kitchen and – incidentally – left the half full bowl of them lying on one of the tables. Since Technarium is a rather messy place, and the kitchen has been under construction with various things lying around, no one noticed the bowl for a while. In that time, one of the "owners" of spaghetti travelled to Berlin for a few weeks' stay.

By the time anyone had rediscovered the spaghetti it was already transformed into a bowl of green mold, with little evidence of what it actually was.



Spaghetti under the microscope.

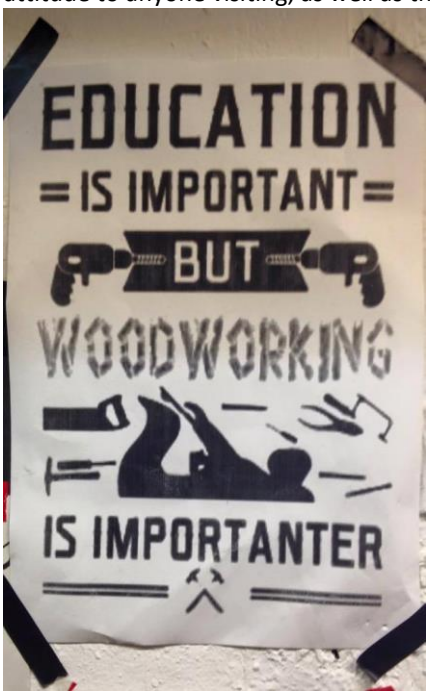
First, the members of the biohacking lab were jokingly "accused" of owning the bowl of mold. They took it rather seriously (it was not *their* mold!), and therefore started a little investigation of what it was and who did it belong to.

Their hypothesis of the moldy stuff being spaghetti was quickly confirmed by another member who, incidentally, also knew exactly who it belonged to. However, once he saw the state the spaghetti was in, he was literally taken aback and suggested it's about time we put them in the blog.

Unfortunately, the story never made it to the blog, but the spaghetti were investigated in great detail in the microscopy workshop the upcoming week, which is when the news of it had travelled all the way to Berlin to one of the original "owners". No one dared to wash the bowl until the "owner" was back. Instead, there was an idea to set up a time-lapse camera!

Box 2. Posters and memes of the electronics lab.

The following posters and memes have been slowly accumulating in one of the main areas of the hackerspace that is often visited by all members and used for events. They demonstrate some of the history and the essential attitude of the hackerspace, and help to relay this attitude to anyone visiting, as well as the newcomers.



"Education is important, but woodworking is importanter" carries multilevel meaning for the hackerspace. Firstly, along with several other posters on the wall, it signifies the importance of "making" and "doocracy" (see section 3.2 The hacker movement), i.e. those who are active in doing and creating are respected more. Secondly, this signifies a "rebel" view that many hackers have against pre-defined and restrictive conditions, such as formalized education. Thirdly, it acts a joke using the word "importanter", which is a misspelling one might make if one had low levels of education, i.e. signifying the low priority of education. Lastly, it is personally linked to one of the members of the hackerspace who had been expelled from school, however is a very talented carpenter. This latter point is the most significant in realizing the important role that informal education may have in some of these hackers' lives.

"Floppy disks are like Jesus. They died to become the icon of saving" is a geeky joke in the interplay of computer technology and software (i.e. program interfaces). It is also suggestive of lack of restrictive beliefs in the hackerspace, such as religion*, and, most importantly, represents an artifact of the computer science/programming history as a whole, of which hacker community is, and has played in the past (see section 3.2 The hacker movement), an essential part.

*note that this may not apply to all members of the hackerspace and should not be interpreted generally this way

4.3.Informal learning in Technarium: observation and interview analyses

4.3.1. Members' attitudes towards science and technology

As described in section 4.2.2, it is the core and other full members that seem to carry the most influence to the hackerspace's "regime of competence". Importantly, this "regime" and the general attitude of core members has from the beginning been closely linked to science and technology, as something active one can (and should) engage in:

[W]e emphasize technical creation as a natural thing as such, we try to demonstrate that science and technology are beautiful and not at all dry [subjects]. (Q17)

In fact, the whole idea in setting up the hackerspace was to address the needs of people who are interested in these subjects, but have only had a chance to engage with them in isolation. According to one of the core members, the hackerspace was created in response to the need of people who:

(…) are interested in technology (for me that also includes the sciences), however they don't know how to start, or have already started something, but remain in isolation. (Q18)

Therefore, regardless of the fact the space was also a response to the needs of space for the existing group of crafty friends (see section 4.2.1), the reason it was opened up to the public was to give everyone a chance to learn about the technology that the existing hackers based their daily and/or leisure lives on.

Similarly, someone who joined the hackerspace later on, but has since become a significant shareholder of the space, including setting up a biohacking lab, explained that even though the primary motivation to join Technarium and move his lab here was the need for space for his own projects, as

well as the ready availability of various tools (see section 4.2.5). He soon realized the added dimension that the hackerspace provides:

Initially I thought [this] will be a commercial project (...), but once the opportunity to join Technarium presented itself, I realized it will be usuful to at the same time allow other people to do what they want [here]... (...) In short, laboratory equipment is really underused, it barely wears off from being used, because it is good quality, and I simply feel sorry that it stands there as an unused resource. So I thought it will be fun if people turn up who want to, who will come and start doing something, studying something for their own good. (Q19)

In his view, the ability to come and try to do their own experiments, such as simply as trying to grow bacteria will demonstrate that:

It's not the saints that make the pots[40]*, it's not aliens that provide information about new technologies that appear, but everything is done by the people, everything is done via relatively easy methods. For example, discovery of some sort of new drug is quite an accurately laid out process that is repetitive, and there is no such stage there that would be associated with some sort of myths or be very inaccessible. So they [people trying things in the lab] will simply realize the simplicity of the whole process.* (Q20)

Therefore, the goal of demonstrating how understandable science can be, as well as demystifying it for the public, is among one of the main goals among the full members in the hackerspace.

Importantly, even though the new members might not actively associate themselves with the same goals or attitudes towards science and technology, the core team and the rest of the full participants, as experts in various science and technology fields (incl. electronics, hardware engineering, software

[40] Lithuanian saying "ne šventieji puodus lipdo", meaning things do not appear out of nowhere, they are made by people and their work.

engineering, physics, biochemistry), maintain a close relationship with the fundamental knowledge about what makes things work, and serve as essential mediators in sharing such knowledge with new members.

This dimension is especially important in the context of the current study, as to argue that a community of practice is a medium for gaining science and technology knowledge and skills, means that these are in fact part of the community's "regime of competence", i.e. the set of competences that peripheral participants must inadvertently acquire through participation to become full members.

4.3.2. Members' attitudes towards learning

The interviews carried out and conversations conducted with Technarium members during the course of this study has revealed a curious pattern in the way both old and new members think about learning, as it applies to participation in the hackerspace. Not a single person has put this as the main or initial goal of joining the space (instead it is usually the availability of tools and space), and do not actively associate the place with any learning agenda (e.g. as they do with a local commercial makerspace[41], which carries out formalized training in the form of courses and workshops). This is not in the least bit surprising knowing the overall nature of informal learning that mostly happens as a side effect, rather than the initial goal of the learner. However, learning always comes up, sooner or later, and seems to be considered by the members almost like a natural extension of what happens in the hackerspace:

A really important thing that we have realized (...) is that you have to learn. Learning [should be] like a way of everyday activity, like the bread you

[41] Green Garage in Vilnius, http://greengarage.me.

eat. (…) you should learn at least 2 things a day! (…) Like Alice [in Wonderland] you should think of 6 things that do not exist before lunch. (Q21)[42]

One of the new members, attending his first member meeting and signing the documents, when asked about his reasons for joining, shared:

Mainly, I've been working on some furniture and I'm sick of fiddling with all the stuff at home… but its fun, because I have ideas, but I don't have knowledge (e.g. of electronics), but here you can communicate, you can learn something…(Q22)

Importantly, encouraging attitude is profound among the core members of the hackerspace, including the goal to reduce the barrier between existing technical creators and the general public:

We invite people, e.g. "would you like to learn programming? Come to us and learn programming! (…) You're welcome, we will all help you!" (Q23)[43]

Importantly, learning in a hackerspace is fundamentally a self-directed process that happens through participation in the active process of creation itself:

We don't concern ourselves with training – if you are keen to learn something, you will definitely find someone who will help, who will tell you if you are doing something wrong. It will happen chaotically, informally. If you want to "be taught" then go to Green Garage; but if you want [to learn] via the samuraj method, then come to us. [laughing] (Q24)

It's not like you will come [to Technarium] and you will receive all the knowledge – no, they will lead you on the way, but then you will have to continue to search for that information yourself… and it's only when you have a

[42] http://www.lrt.lt/radijas/laidos/1603
[43] http://www.lrt.lt/radijas/laidos/1603, 45:00

specific problem is when you can explore it… you will not receive processed information here, it will not be transferred to you like via a USB flash. [smiling]

But at least at the university you cannot go to the teacher and say "give me this tool! Teach me this!", but you can do so in Technarium. [laughing] (Q25)

However, the lack of educative attention and systematic guidance does not seem to be a barrier to most people who join:

Perhaps most often people who join us and stay are independent, and able to formulate problems, you don't need to tell them "now learn this, do that", they come and say "I would like to understand this, I would like to make this for myself, perhaps you can help me, or you can give me the tool?" I'd say these are the majority; these are independent and daring people. (Q26)

To most members, learning seems an organic extension of the practice within the hackerspace, rather than being a specific goal. It is like a side effect that you cannot help, but that also makes it exhilarating to be part of the community, rather than work in isolation.

We don't exactly have a specific goal to create, to innovate – that happens sort of by accident, when people come and do things simply because they can do them. Do them because they have tools, they have ideas – ideas are the most important. We also promote the sharing of this knowledge. (Q27)

The core and some full members themselves emphasize the value of the different expertise that crosses path in the hackerspace:

The most delighting thing is that every time when you come there's a chance to learn something – maybe a chemist will explain something, maybe the programmers will talk about something interesting, you can always ask the electronics guys to organize a workshop about some topic of concern, or go to the carpenters for advice. (Q28)

According to one of the founders of the biohacking lab, this was also the main reason why he was encourages by one of the existing members to move his lab to Technarium:

[He said,] "oh, that'd be quite awesome if there was something like a laboratory here, because everyone else is taking up some sort of crafts, but there is no one who is doing something with chemistry." (…) And then I thought it would actually make sense to join, because at the same time there are other areas, other mechanisms one can work with, which is very convenient because, say, I am working with chemistry, but I need some sort of equipment, and there is the entire workshop, the entire infrastructure, and I can do it right there. Or I come up with something, some sort of a holder [for the biolab equipment] and I can at once go and 3D print all of it. (Q29)

The fact that members value this variety means they are also not afraid to interact outside their own specific domain, and the core members also encourage others to do so. For example, when one member had an idea about an electronics project that would benefit her own activities, but had little knowledge of electronics, therefore lacked the confidence to ask other members, one of the core members encouraged her to do so. In the end, the project took off and proved to be a fruitful collaboration[44], in which each member had their own role, including programming, electronics engineering, scientific guidance and communication. The project was recently included in a program of an international conference, in which the members participated[45].

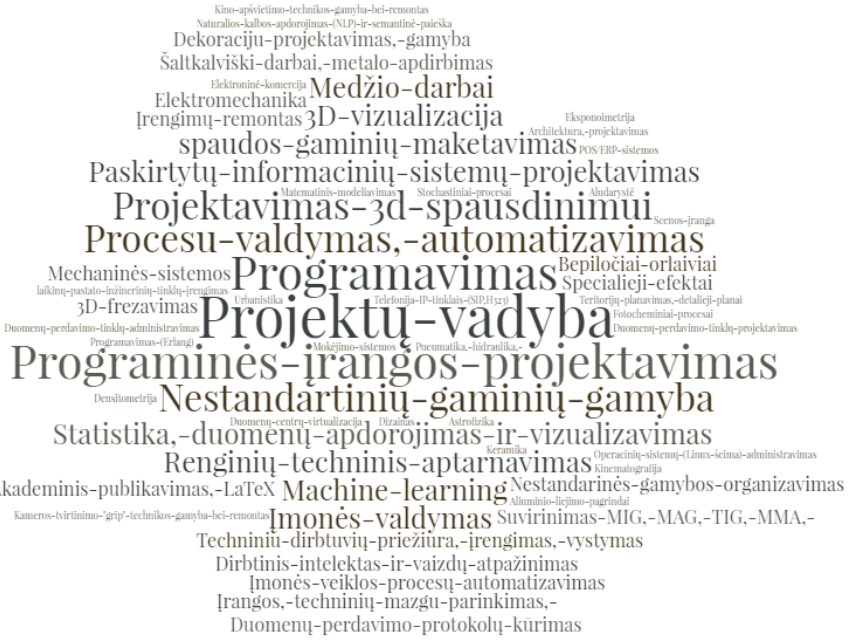
The diverse interests also create unexpected opportunities for learning, as members may stumble on something by accident that they would not

[44] https://hackaday.io/project/11088-camera-traps-for-citizen-science
[45] https://sites.google.com/a/gold-mobileinnovation.co.uk/ecsa2016---citsci-thinkcamp/About-the-Think-Camp/the-challenges/7-the-motion-sensing-camera-trap-challenge

have thought of pursuing before. For example, when asked about what kind of people will likely be involved in the biohacking lab, one of its owners answered:

Well, first of all, all of those who are interested in one of Technarium's activities in general, because people of very different profiles come here, from brewery to arts installations, sculptures… And some of them get in fact get interest, in fact people of diverse profiles come. But what they all have in common is that they are curious and want to improve. (Q30)

This has been evident in various cases of learning, especially the microscopy workshop described in section 4.3.3. For a stab at some of the member's competences, see Figure 7. Word cloud based on Technarium members' competences (in Lithuanian) and their frequency (i.e. how many members share one competence, ranging from 1 to 6). The 6 most common competences are "project management", "software design", "programing", "non-standard product production", "process control, automation", "3D printing design". Note that this does not represent all members, but only those who have submitted answers to a form shared within the mailing lists (13 members in total out of ~80).



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Another important factor of the general attitude towards learning in the Technarium is the intrinsic need to understand things, which is encoded in the hacker ethic (see section 4.2.4), rather than unknowingly fiddle, mass produce or consume the mass produced things:

Hacker is someone who cares about the fundamentals about the phenomenon, and full control of technology, not just being content with the crumbs that some provider of a phenomenon leaves us. (…)

We are about opening the phenomena and about the fundamental knowing. It's not like we make things that are beeping and blinking nicely – we also want to know why is that thing beeping and blinking. (Q31)

According to Himanen (2001), the way most hackers usually learn (be it programming or another domain they are hacking in), is by "setting up an interesting problem" and "working toward a solution by using various sources" (p. 73). This is intrinsic to Technarium as well:

[Technarium] is not just a space where people work – of course there's work here – [but] it is also a place to meet like-minded people, people who just cannot go to sleep until 3am, because he discovered something and he just cannot go to sleep until he figures it out. Therefore we try to create a space to meet like-minded people, curious people like that. (Q32)

Another member shares how it is always interesting to come to the Electronics Mondays, since there is often a real problem or even "mystery" to be solved, such as the DIY lights having gone out in one part of the electronics lab, which were traced to a poor power source and this in turn – to a malfunctioning transistor, which had to be fixed in order to prevent future failures.

Those Mondays are very interesting, since you casually chat and at the same time can solve some sort of an interesting problem… At home there would not be such a problem as mysteriously failed lights. [laughing] Besides, at home you'd just sit and watch YouTube videos, but here it's a lot more fun. (Q33)

Clearly, not all Technarium members might share all of these views. Regardless, since core and other full members hold the most influence over the "regime of competence", other members are expected to realign with similar thinking as they move from peripheral to full participation in a community of practice, and, therefore, be open to the sharing and learning opportunities that the space offers. That is not to say that the views of new members do not matter – on the contrary, the attitudes of Technarium as a whole may change in the coming years as new members replace the old. Importantly though, the newcomers

interviewed and observed during this study, seem to share similar views about learning in the hackerspace at the moment.

4.3.3. Cases of informal learning of science and technology in Technarium

The members' accounts and observations described so far in sections 4.3.1 and 4.3.2, demonstrate the applicability of the informal learning model proposed by Marsick & Watkins (2001) and others. Learning in Technarium seems to 1) be situated in everyday activity, i.e. making/hacking; 2) arise from experience and naturally occurring problems; 3) not be the primary goal nor a highly conscious activity; 4) be dependent on peer guidance and peer learning. In fact, these observations align well with the characterization of informal learning in the workplace by Marsick & Volpe (1999), which further supports the use of this model.

However, it is important to illustrate when and how exactly does science and technology learning happens in the hackerspace. Importantly, such learning, according to the communities of practice model, occurs via mutual engagement, and could be observed in a multitude of interactions between Technarium members, including working on an everyday project, fixing or cleaning a piece of equipment etc. Here I present those cases of science and technology learning that have been the most impressive and/or arose most unexpectedly, and involved several people (rather than just a pair of people working on a particular project day to day, for example).

Members' night (social evening), 2016-03-10:

1. **Elephant toothpaste.**

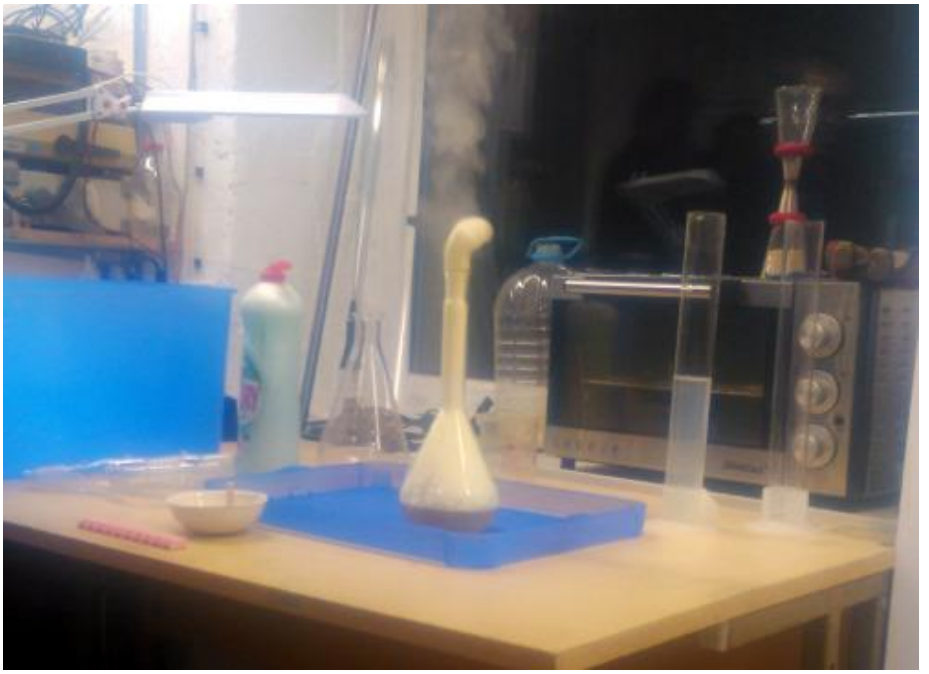

Figure 8. Elephant toothpaste experiment by biolab crew.

The "Elephant toothpaste" was a chemistry experiment[46] carried out for fun at the first members' night at Technarium. The protocol included mixing hydrogen peroxide with liquid soap and potassium iodide, which caused an exothermic reaction (i.e. emitting heat), which was vigorous enough to send bubbles of soap shooting out of a flask.

The first try of the experiment happened really fast and cause a lot of enjoyment among the members. The second round the members were already discussing of the best way to mix chemicals. In the end, a different method of mixing the chemicals was used (first adding potassium iodide, and then – hydrogen peroxide), which resulted in a less active reaction. This effect immediately became a subject of discussion as well, although no clear answer was reached (the biochemist did not know exactly why), the members learned to formulate a question concerning a chemical reaction.

[46] https://en.wikipedia.org/wiki/Elephant_toothpaste

The next questions that followed were:

- Why is there “smoke”?
- Why is the foam hot?

(answer to both of the above questions – exothermic reaction)

- What gas is emitted in the reaction? Is it H_2? (answer – O_2)
- What would happen if H_2 was emitted? (it would be highly explosive)
- How much of H_2 should be emitted for the reaction to be safe?
- Is the resulting “toothpaste” dangerous to touch? How will we dispose of it? Is it safe to put it in the sink?

Following the experiment, the biolab crew also carried on trying to decipher the chemical equation involved, which is complicated by the involvement of hydrogen peroxide (H_2O_2). Their efforts were aided by one other participant who used his high school chemistry knowledge to help. The solved equation (as well as the crossed out “failures” written down in the process) remained on the whiteboard in the electronics lounge for weeks.

While it is difficult to precisely know how much and what exactly was taken in by each participant, it is clear that everyone at the meeting, especially the most active participants, at the very least, were able to learn about: 1) exothermic reaction; 2) gas that is emitted by breaking down H_2O_2; 3) H_2 vs. O_2 and their safety; 4) possible toxicity of various chemicals and reaction products; 5) basics of conducting a chemical reaction; 6) chemical theory behind the reaction (e.g. equation).

2. Laser “peeling”

Figure 9. Lasers peeled out of their laser pointer cases by members at the event.

Several members at Technarium had been constructing an open source laser labyrinth[47] with primary use as a fun attraction in faires, events and Technarium itself. One of the members had bought some cheap laser pointers since, apparently, this is a much cheaper way to acquire low-power lasers. In the middle of the members‘ night, he brought the laser pointers and starting peeling them to get the lasers out.

This was first met with some friendly sneering from the other members – “is this really the best way to buy lasers?” and “and you are going to peel them all now?!” However, then other members, one after another, started taking pointers and peeling them using their own pocket or improvised tools, and discussing the best methods to do so. After a while, there were hardly any people around the table not peeling a pointer.

In the process the members discussed:

- the possible production process of the cheap laser pointers, and their flaws;
- the ways to use the empty cases of the pointers;

[47] http://blog.technariumas.lt/post/144187541646/an-open-source-modular-laser-maze

- the physics of the lasers and whether or not they were dangerous to look into with naked eye; this latter discussion revealed that one of the members at the table was actually a physicist who has been working with lasers for most of his working career. This of course resulted in a lot of technical conversation that he and the owner of lasers were the most active participants in, while most of the other members listened keenly and occasionally asked their own questions. In the end, the physicist has invited the laser owner (who was indeed the most interested in laser physics) to visit the lab he used to work in.

This way the members gained knowledge in: 1) the technological process of laser pointer production, including the use of various metals; 2) how dangerous are different lasers, relative to their power; 3) polished their creative skills in using leftover parts of the pointers. One member also gained an enhanced opportunity to visit a laser lab and explore the science and technology of the domain even further.

3. Lichen & moss graffiti

Since the theme of the social evening was "Whatever I am working on", one of the core members asked one of the other participants at the table to share details of her recent lichen project[48], and in general demystify what kind of projects they were working on in the biohacking lab.

After explaining the reason and basic procedure for looking for biosynthetic products in the lichen, the member explained that this might be the only way to study lichen as they are understudied and very difficult to study in the lab by traditional methods. Some of the members wanted to know why, so they discussed the usual methods of growing organisms in the lab, and it was explained that lichens are too slow to grow.

This is when one of the members shared his lichen and moss graffiti idea, which was generally well accepted. However, he was taken aback when the lichen "expert" explained lichens grow for years and, therefore, might not be so suitable for graffiti (he previously thought it would only take a few weeks for them to grow).

[48] http://blog.technariumas.lt/post/140081910826/biohacking

After checking the exact growth rates of lichen the next day, the lichen “expert” also followed up with the graffiti idea-author later on, and further discussed the usefulness of moss for this purpose.

This way the whole group was able to learn the basics of lichen science and what some of the obstacles are in the scientific process, as well as how such obstacles may be overcome by citizen science and biohacking. The graffiti idea-author, who had a more “personal” connection to the issue of lichen and moss biology had a chance to engage in this learning even deeper.

4. Microcroscopy of a microcontroller

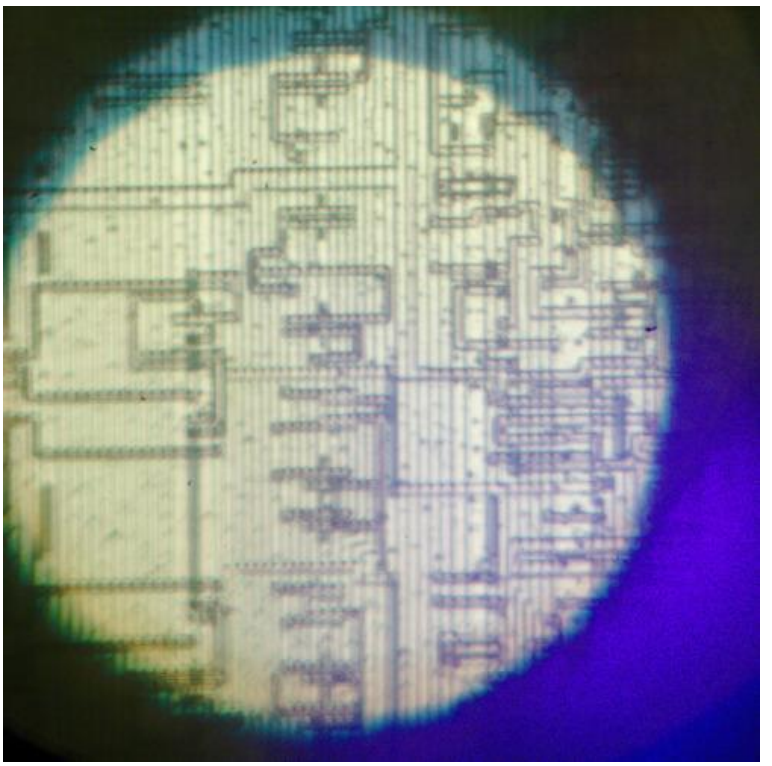

Figure 10. Microchip under the microscope.

In the same social event someone (a programmer) had an idea that it would be cool to see how a microcontroller looks magnified. Incidentally, one of the biohackers had already revived an old fluorescent microscope and could in principle set it up for viewing. They therefore set up to dust, plug in, and regulate the microscope.

By the time the microscope was ready, there were already two more people waiting to see how the chip would appear[49]. The people with electronic expertise were fascinated:

- "You can see the "0" and the "1"!"
- "We can reverse engineer this!"
- "So this is what memory looks like!"
- "What would happen if we heated it/exposed it to UV? Would it erase like the old types of computer memory?"

This incidence of learning was particularly fascinating as the conditions for it happening were unique to the hackerspace housing so many different expertise and tools. Mainly, the playful idea to look at the old microchip came to a programmer, but was immediately met with enthusiasm by a biohacker who had both knowledge of electronics and microscopy, as well as a working microscope in his lab that he could adapt for this purpose.

The people who were experts in electronics and programing learned essential microscopy skills and where able to look "deeper" into the medium they work with every day and imagine it from a different perspective, that influenced further creative ideas (like reverse engineering). The biochemists were able to learn about the basic structure of the microchip and look at their domain differently, which is also when they got an idea to set up a "creative microscopy" workshop, where people could look at whatever they think off – not just the standard biological microscopy samples.

5. Creative microscoping

One of the inaugural events of the Technarium biolab was a microscopy workshop[50] that happened on a Sunday and was open to all members. It took place in the lounge, so multiple members migrated by during the few hours.

One of the most active participants was a girl who was working in a ceramics workshop nearby when the workshop started. She started by looking at some yeast that were already set up under the microscope; when she heard that the theme was "microscope anything!", she started bringing all kinds of things from her station, as well as plants from nearby window, to microscope. At first she needed help to

[49] http://blog.technariumas.lt/post/140981692236/eeprom-through-a-microscope
[50] http://blog.technariumas.lt/post/143983462201/microscopy-workshop

set up the microscopes, but with some guidance and encouragement from the biolab crew she started doing it herself.

Among the things microscoped were:

- Yeast (brought by the biolab)
- Mould from abandoned spaghetti in the kitchen
- Plant leaf
- Moss
- Heath flower
- Dusty spider web
- Turtle shell
- Carbon paper
- Various stones
- Ceramics beads

The most interesting observations made by the most active participant was that the yeast and the turtle shell are similar in a way and "remind of the surface of the sun". When asked why, she struggled to explain it, but with help from other members started talking about patterns, and was moments away from starting an actual investigation when she got distracted with the other samples.

Another member brought a sample of what he claimed to be a "lichen". However, the lichen & moss lover at the workshop quickly explained that what he actually brought was moss, showed it under the microscope and explained why lichen would not appear so fleshy.

There was also an investigative discussion of a strange looking leaf, which had hairs along its veins. After sharing various levels of knowledge about different functions of leaf hairs and properties of various plants, a likely plant type was discovered and the purpose of hairs explained.

Carbon paper was one of the most unexpected views under the microscope that fascinated everybody (Figure 11. Carbon paper under the microscope.). A strange phenomenon of crystals moving was also observed. Unfortunately, there were no inorganic chemists and physicists at the workshop who could help explain it.

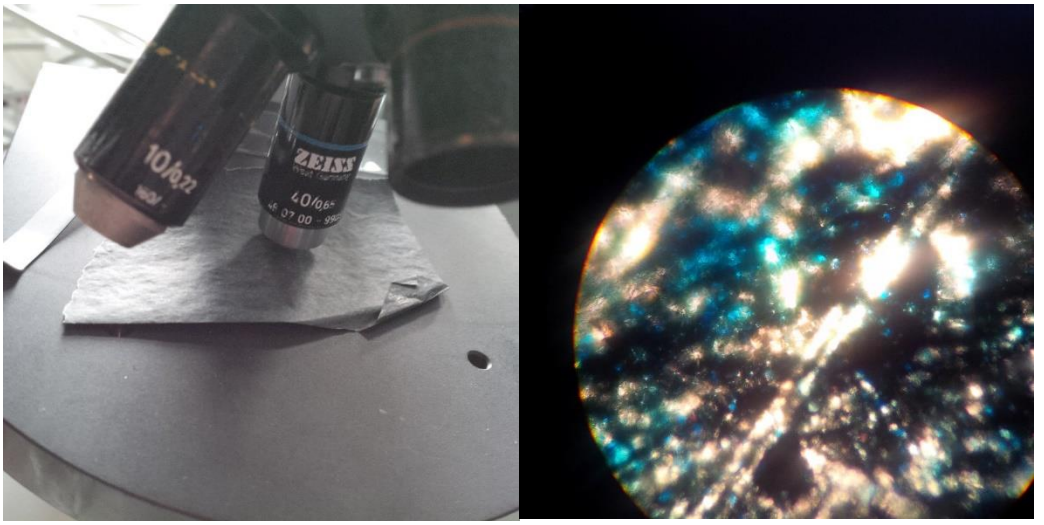

Figure 11. Carbon paper under the microscope.

Curiously, one of the biohackers was frustrated at not being able to see samples properly on one of the microscopes that he had revived from a non-functioning state before. The microscope has been used before, however without the said member, who is the only one in the biolab that also has enough technical knowledge and fixes, as well as builds his own equipment. That is why nobody had dared to change anything on the microscope before.

After some fiddling, the biohacker suddenly shouted “finally, now I know how this works!”, took some piece apart and put the microscope back together to produce a much better view.

At this point, another member with more electronics expertise turned up and, witnessing the win for the microscope, started discussing the optics and lighting of the microscope. He then also noticed an old switch where the camera might have been attached and started a discussion of the previous design and the technical ability to attach a camera to the microscope now. While the discussion was mostly carried out by the two members, the other listened to large parts of the conversation while working on different microscopes.

4.4.Discussion

The cases of informal learning presented in section 4.3.3 serve to demonstrate a few important elements characteristic to the informal learning in the hackerspace that might not be present in other places of informal learning (e.g. museums):

1) Ability to explore tools and phenomena actively, via participation and construction of meaningful things (or taking them apart);

2) Safe environment to experiment, a fun, liberal and supportive community;

3) Network of people with various, sometimes very different knowledge and expertise;

4) Community of *curious* people and the general attitude of wanting to know;

5) Experience that is learner-centered and controlled by the learner herself (e.g. by selecting which activities and how deeply to participate in);

6) Experience that is social, i.e. both the activities and the success of learning depends on the community of peers, who enjoy sharing their knowledge and learning from each other; the ultimate "evaluation" also depends on being successful among your peers.

While the entire scope of learning outcomes cannot be generalized to each and every member in the hackerspace, it is obvious that the characteristics above create rich learning opportunities in myriad disciplines at Technarium, including electronics, physics, biosciences etc. The members have an opportunity to gain content knowledge, as well as (and this is very important) to pose their own questions and problems that can then be explored with the help of knowledgeable peers, or by using the various tools and equipment available at the hackerspace continue to explore these questions on their own accord. Such self-

directed learning may be the key element of the success of the hackerspace as an informal learning environment, both from the perspective of hacker mentality (Himanen, 2001), the nature of informal learning as the construction of one's knowledge (Bell et al., 2009), and gaining key competences to continue learning further in life.

Importantly, the success of learning at a community of practice, as proposed by (Wenger, 1998), depends on one's ability to become a full participant of the community, in this case – the hackerspace. As demonstrated in sections 4.2.3-4.2.5, the community has a number of distinct values and ways of communication that need to be learned to participate fully. Moreover, Technarium's "regime of competence" is very much based on the specific attitudes towards science (4.3.1) and learning (4.3.2) as well. Therefore to be successful in Technarium means to realign with these attitudes – in other words, people who join Technarium with different expectations, e.g. hoping to learn by formalized methods such as regular workshops or be supervised every step of the way, are likely to fail and not benefit from the informal learning opportunities the hackerspace has to offer. On the other hand, no formal entry barriers exist at Technarium, and anyone interested can visit and, later join the hackerspace to explore the unique settings of technological creatorship and science exploration that is possible here.

However useful is the community orientation in Technarium, it is not without its limitations. To begin with, the specific language and manner of communication might be a barrier to new members, who may struggle or fail completely to communicate with full members and therefore be cut off from the educational experiences the space offer. Community management is largely carried out my core and other active members, however, this requires a lot of work and resources as depends on the conversion of new members to full members to

fully sustain this dynamic. This also applies to other roles of management, as they are carried out completely voluntarily in the hackerspace and are resource intensive. Moreover, since most decisions are made with the community (i.e. no one member has a "bigger" say than the next), the decision making process can sometimes be frustrating. And lastly, due to the liberal nature of hackerspace community, other challenges arise, such as members not paying their fees on time, and the hackerspace struggling to survive.

Regardless of its limitations, community seems to be the main mechanism via which knowledge and attitude towards science and technology is transmitted in Technarium. While these results cannot be generalized to all hackerspaces, the assumption that those who identify themselves with the general hacker ethics may demonstrate similar attitudes and community dynamics, as well as learning patterns, is a strong one. In the future, it will be good to see case studies of other hackerspaces worldwide, following the communities of practice framework. On the local scale, it will also be useful to carry out comparative studies of the different makerspaces that have popped up recently in Lithuania and seem to be very different in education scope, including Green Garage, Kaunas Makerspace and others.

CONCLUSIONS

The current study on informal learning has demonstrated that:

- The communities of practice model is useful for studying informal learning in the hackerspace, due to its community dynamics and the social dimension imbedded in the peer-production attitude and the hacker ethic;
- Technarium carries many elements characteristic to communities of practice as defined in Wenger (1998, 2010) and other works (*hypothesis 1*);
- Technarium members do not consider learning as the main goal to join and participate, however it almost always comes up as an appreciated "side-effect" of participation in the hackerspace, as is often linked to the diverse nature of the community (*hypothesis 2*);
- Technarium "regime of competence" is embedded in the desire to tinker with and understand various phenomena, as well as share knowledge and increase the public understanding of science (*hypothesis 3*);
- Due to the diverse expertise of Technarium members, and the availability of various tools, the hackerspace allows learning across different science disciplines and exploration of different technologies (*hypothesis 4*);
- The success of participation in Technarium and, therefore, the effectiveness of learning, lies largely on the availability to communicate in the language and manner of full members, which can be a limitation for joining and succeeding in Technarium. This limitation is partially overcome by the ability of oldtimers to communicate in both – the language of the community, and the language of the newcomers;
- Learning in Technarium is self-directed, unstructured and sporadic, which fits the informal learning model well. However, this may be a limitation to those seeking systematic and constant guidance in their learning.

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DEFINITIONS

Biohacking – a type of hacking that concerns the biosciences, including investigation of nature, molecular biology, synthetic biology and art creation with natural or engineered live forms

Biolab – used synonymously here with a biohacking lab

Citizen cyberscience – citizen science that happens exclusively online, e.g. via citizen science online platforms, such as Zooniverse[51]

Citizen science – the participation of the lay public in the scientific process, either by collection or analysis of data, or the entire process of scientific research

DIY culture – "do-it-yourself" culture concerns making of own things with tools and materials available to an individual or a community, usually making things that are either too expensive or not good enough commercially, or inventing new things and their configurations

Fablab – type of makerspace focused almost exclusively on materials fabrication (such as 3D printing), usually focused on the educational agenda and attached to educational institutions, such as universities, libraries, museums etc.

Hacker (hacking) – someone receptive of at least some aspects of the hacker ethic, which values active creatorship, the freedom to design own lives, the value of sharing and peer-recognition and working out of passion and responsibility to one's environment, rather than monetary value

[51] https://www.zooniverse.org/

Hackerspace – type of makerspace focused on tinkering with phenomena and pushing the boundaries of technology at the intersection of digital and physical fabrication

Maker (making) – someone involved in the DIY culture, mainly through participation in various makerspaces

Makerspace – creative DIY spaces that facilitate the culture of "making" by the availability of a community space and shared tools, such as 3D printers, laser cutters, CNC mills etc.

Open hardware – the alternative of open source in the form of hardware, in which plans and components are shared freely and can be copied and modified by anyone

Open source software – software of which source code is freely available and can be copied and modified by anyone

APPENDIX I

Technariumo narystės taisyklės

(galioja nuo 2015 rugsėjo 1d.)

Technariumo nariu/nare galima tapti atlikus žemiau esančius veiksmus:

1. pasirašytinai susipažinus su šiomis taisyklėmis
2. apžiūrėjus Technariumą dalyvaujant kam nors iš prižiūrinčių narių
3. pateikus užpildytą ir pasirašytą narystės sutartį, parodžius asmens dokumentą įgaliotam prižiūrinčiam nariui
4. įmokėjus pirmą narystės įmoką
5. pateikus galiojantį elektroninio pašto adresą (jį prijungsime į Technariumo pašto konferencijas).

Technariumo narystė suteikia:

1. teisę patekti į Technariumo patalpas bei jose dirbti su asmeniniais/bendrais projektais.
2. teisę (priklausomai nuo narystės rūšies) naudotis bendrais įrankiais ir įranga, esančiais dirbtuvėje. Kai kuriais įrankiais ir įranga (suvirinimo aparatais, juostinėmis metalo pjovimo staklėmis, gręžimo staklėmis, trimačiais spausdintuvais, tekinimo staklėmis, frezavimo aparatais, kampiniais šlifuokliais, medžio pjovimo staklėmis, keramikos krosnelėmis bei metalo liejimo įranga ir kt.) galima naudotis tik leidus bei apmokius atsakingam nariui. Ilgiau trunkantys bei medžiagų sąnaudų reikalaujantys apmokymai gali būti mokami.
3. teisę dalyvauti narių susirinkimuose ir kartu priimti sprendimus apie dirbtuvių veiklą, būti informuojamiems apie dirbtuvių veiklą ir finansinę padėtį, dalyvauti renginiuose.

Technariumo nariai įsipareigoja:

1. Palikti bendras darbo vietas tvarkingas, padėti medžiagas, įrankius ir įrangą jiems skirtose vietose, nepalikti šiukšlių ir gamybinių atliekų.
2. Savavališkai nesinaudoti dirbtuvių įranga. Dirbtuvės pagal darbo specifiką yra padalintos į atskiras zonas. Nariai gali pradėti naudotis šiomis zonomis tik gavę už tą zoną atsakingo asmens sutikimą. Konkrečius įrankius, įrenginius ir medžiagas, kuriomis toje zonoje tuo metu gali naudotis konkretus narys nustato už tą zoną atsakingas asmuo pagal individualius nario sugebėjimus.
3. Saugoti bendrus ir asmeninius įrankius bei įrangą. Sugadinus bendrą ar asmeninį kito nario daiktą, sugadinęs narys pilnai atsako už jo pakeitimą ar pataisymą. Jei įrankio pataisymu užsiima kitas dirbtuvės narys, darbas bei medžiagos gali kainuoti atskirai.
4. Asmeniniais kitų narių įrankiais ir įranga galima naudotis tik gavus nario sutikimą. Įrankiai, įranga, bendros medžiagos negali būti išnešami iš dirbtuvių be atskiro susitarimo. Dirbtuvėse esančiomis medžiagomis (medžio ar metalo ruošiniais, elektronikos komponentais, trimačio spausdintuvo plastiku, etc.) galima naudotis gavus atsakingų narių sutikimą bei galimai padengus jų kaštus.
5. Pilnai atsakyti už pasikviestus svečius, nepalikti jų vienų. Maži vaikai turi visą laiką būti prižiūrimi atsakingo asmens ir negali būti darbo zonose. Dirbtuvėse negalima laikyti gyvūnų. Gyvūną atsivedus trumpam, šeimininkas privalo juos prižiūrėti ir nesivesti į darbo vietas. VšĮ "Šviesos Kūgiai" neatsako už pašaliniams asmenims ir jų nuosavybei sukeltą žalą.
6. Galios įranga ir įrankiais, taip pat kai kuria kita įranga galima naudotis tik išklausius periodiškai organizuojamus apmokymus ir pasirašius darbų saugos žurnale. Narys, pasirašydamas darbų saugos mokymo žurnale, pripažįsta, kad susipažino su įrankio ir įrangos veikimu bei saugiu jų naudojimu.
7. Neblaivūs ir apsvaigę asmenys negali naudotis dirbtuvių įrankiais ir įranga bei būti darbo zonose.
8. Darbo su galios įrankiais ir įranga zonose negalima garsiai klausyti muzikos bei dirbti su ausinėmis.
9. Nariai sutinka, kad vidinio administravimo ir apskaitos tikslais būtų saugomi ir tvarkomi visi ar kai kurie iš sekančių jų duomenų: vardas, pavardė, el. pašto adresas, telefono numeris, banko sąskaitos numeris.

VšĮ “Šviesos Kūgiai” įsipareigoja be asmens sutikimo neperduoti asmens duomenų trečiosioms šalims.

10. Narys privalo pateikti teisingą savo el. pašto adresą, o jam pasikeitus – nedelsiant apie tai informuoti atsakingą už pašto konferencijas asmenį. Narys privalo savarankiškai pasirūpinti, kad į jo nurodyto el. pašto dėžutę siunčiami laiškai iš domeno „*technarium.lt*“ nebūtų atmetami.

11. Technariumo dirbtuvėse nevykdyti projektų, jei jie prieštarauja LR įstatymams ir teisės normoms.

Atsakomybė ir rizika

1. Technariumas (atstovaujamas VšĮ “Šviesos kūgiai”) yra bendruomenę atstovaujantis tarpininkas tarp narių, pastato valdytojo ir kitų trečių šalių, o ne komercinis paslaugų teikėjas. Technariumas įsipareigoja iš narių gautus resursus panaudoti visų narių viešai sutartais tikslais, tokiais, kaip nuoma ar nauja įranga, viešai skelbti finansų paskirstymą, bet neįsipareigoja užtikrinti pastovaus įrankių ir įrangos veikimo ar patogių darbo sąlygų.

2. Priklausomai nuo narystės tipo, nariai gali turėti asmenines darbo ir sandėliavimo zonas, kuriomis naudotis kitiems nariams be tos zonos naudotojo leidimo draudžiama. Šiose zonose nariai gali laikyti tik asmeninius daiktus (įrankius, medžiagas ir pan.), o bendro naudojimo daiktai jose gali būti tik jų naudojimo metu. Technariumas įpareigoja narius laikytis asmeninių zonų privatumo, tačiau to negarantuoja ir neprisiima atsakomybės už su šių taisyklių nesilaikymu susijusiomis pasekmėmis (pvz. dingę ar sugadinti asmeniniai daiktai).

Dirbtuvių veiklos koordinavimas ir komunikacija

1. Pagrindinis Technariumo valdymo organas – visuotinis narių susirinkimas. Jis vyksta dirbtuvėse kiekvieną pirmą mėnesio antradienį, nebent narių būna nutariama ir viešai pranešama kitaip. Susirinkime sprendimų priėmimui pakanka paprastos balso teisę turinčių narių daugumos.
2. Pagrindinis Technariumo bendravimo kanalas – el. pašto susirašinėjimo grupė. Visi nariai įtraukiami į el. pašto grupę *crew@technarium.lt*, o nutraukę narystę yra iš jos pašalinami. Visi esminiai pranešimai, įskaitant pranešimus apie šių taisyklių pasikeitimą, siunčiami į šią grupę.
3. Finansinė kiekvieno mėnesio ataskaita yra skelbiama šioje el. pašto susirašinėjimo grupėje.

4. El. pašto konferencija *technarium@technarium.lt* yra vieša ir skirta platesnio pobūdžio diskusijoms.

Taisyklių galiojimas

1. Aktuali taisyklių redakcija skelbiama Technarium skelbimų lentoje bei yra talpinama adresu *http://technarium.lt/taisykles*.

2. Taisyklės ir jų priedai gali būti keičiami be atskirų narių sutikimo bendru sprendimu, iš anksto apie tai visiems nariams pranešus el. paštu prieš 30 kalendorinių dienų. Jeigu narys nesutinka su taisyklių pasikeitimu ir yra sumokėjęs į priekį už ilgesnį laikotarpį, nei galioja sumokėjimo metu galiojusios taisyklės, jam, abipusiu sutarimu, iki apmokėtos narystės pabaigos, gali būti taikomos kitokios taisyklės. Tokio sutarimo nepasiekus, nariui yra proporcingai grąžinamas sumokėtas narystės mokestis už laikotarpį nuo naujų taisyklių įsigaliojimo iki apmokėtos narystės pabaigos.

Su narystės taisyklėmis susipažinau:

_____

_____

(vardas, pavardė, parašas)

data:

APPENDIX II

"Inauguration letter" sent to all new members (original in Lithuanian):

Prie Technariumo šiomis dienomis prisijungė [member's names]. Welcome ir laukiam ')

Šiek tiek info:

Elektronikos dirbtuve galima naudotis bet kada, apie įrangą galėtų papasakoti mic (albertas@technarium.lt). Su 3D spausdinimu supažindintų Kiprianas (kiprianas@technarium.lt). Metalo dirbtuvę prižiūri Tomas (tbekeris@gmail.com). Galios įranga galima naudotis po apmokymų, kurie vyksta pora kartų kas mėnesį.

Kiekvieną pirmadienį 18:00-21:00 vyksta elektronikos būrelis -- neformalus susitikimas, kurio metu galima pasiaiškinti klausimų, padaryti kokį nors laboratorinį darbą, ką nors padeginti ar išmatuoti.

Pirmą mėnesio antradienį, 19:00, būna susirinkimas,
kurio metu sprendžiame einamuosius klausimus ir susimetame kito mėnesio nuomai.

Antradieniais 19:00 vyksta Erlang'o būrelis, kartais ketvirtadieniais -- sintezatorių mėgėjų meetup'ai ar kiti renginiai (http://www.meetup.com/Technarium/).

Už narystę kas mėnesį, iki 15 dienos, metamės taip:

VšĮ "Šviesos Kūgiai"
SEB bankas
LT23 7044 0600 0804 2536
Mokėjimo paskirtis: narystės mokestis už XX mėn.

Turime blog'ą (http://blog.technariumas.lt), wikį: (http://wiki.technariumas.lt/), failų saugyklą (http://cloud.technariumas.lt/, user:crew, pass:KadFailaiKazkurGuletu), taip pat Twitterį (https://twitter.com/technarium), Github'o account'ą (http://github.com/Technariumas/), Hackaday account'ą (https://hackaday.io/hackerspace/7105-technarium), išsamesnį projektų archyvą http://wemakethings.net, dar kažkokio ūkio.

[members] mailing list'as -- vidiniams reikalams, [crew] -- paklausimams iš išorės, [technariumas] --
platesnėms diskusijoms, kurios gal įdomios ne tik nariams, bet ir

prijaučiantiems.
Srauto čia būna gana daug, siūlau susikonfigūruoti pašto kliento filtrus taip, kad pagautų laiškus iš [crew], [members] ir [technariumas].

PRAŠYMAS -- atsiųskit (man) savo daromų dalykų nuotraukų/aprašymų/kodo -- dedam visą
tai į blog'ą (http://blog.technariumas.lt/). Nesvarbu, ar tai feilas, ar eksperimentas, ar prototipas, ar tik proceso dalis, ar rimtas projektas, ar sugadintas įrankis, ar įsirengta darbo vieta ;)

Susitiksim, matyt, dirbtuvėse.

APPENDIX III

Below are the original quotes acquired during interviews and observations. Original quotes are presented in Lithuanian or in English (as they were originally said) and are not truncated. Quote numbers (Q1-33) correspond to those indicated in the text.

Q1: *Technariumas išaugo iš draugų būrio, iš kurio labai daug žmonių užaugo su tėvais, kurie turėjo dirbtuves, vienokias ar kitokias. Dar taip pat gana smarkiai buvome ir esame susiję su pankroko ir DIY subkultūromis, todėl jau labai seniai, kiek save atsimenu, kažką darėme -- šilkografiją, elektronikos bandymus, kažkokius baldus sau.*

Ilgainiui viename undergroundiniame Vilniaus klube, rūsyje, įsirengėme dirbtuvėlę -- ten iš esmės buvo elektronika ir šiek tiek kitokių įrankių.

Q2: *Kai kurie žmonės buvo pradėję dirbti teatro technikais -- gamindavo jiems dekoracijas, kitokius techninius sprendimus, šviesas. Pradėjom netilpti rūsyje, nes ten buvo vietos 5 žmonėms ir tai 2 aukštais, todėl išsikraustėme į grąžtų gamykloje esantį angarą. Ten buvo daug vietos, šalta, drėgna, nesvetinga, tačiau galėjome viduje daryti visokius didesnius projektus*

Q3: *Šiandien prie musu, ir kartu su mumis jungiasi nauji žmonės, Aurimas, ir keli jo kolegos, kuriu vienas, Mantas jau ir taip dirbtuviu narys.*

Jie gan greitai, iki kovo mėnesio turi išsikraustyti iš savo patalpų audėjo magykloje, tad ateina ir ima tuščią sale antarme aukšte. Su Aurimu kalbėjome kad jau kita savaite imtusi ja tvarkyti. paskui ir atsivežtu turimą įrangą bent jau pasidėt.

Dabar kyla esminis klausimas kaip mum ir jeim norėtusi būti kartu? galbut perdisluokuoti turimas erdves ir paefektyvinti plotus?

Chebra is esmes uzsiima kino dekoro gamyba, daro maketu ir pan. tokie carpentry darbai, ir medzio darbai. Jiem reikalingas plotas kur galima butu padrozt putplasti, papurkst dazu, pasidet projekta prie kurio dirbama savaiciu, manau tai persikloja ir su dalies musu veikla.

Taip pat reikia vietos, kur statytusi lazeri ir CNC staklytes kuriomis irgi dirba.

Tai va, kviečiu tuos kam idomu susipažint ir dalyvaut sumastyme kaip mum kartu subuti ir pasigerint erdviu išnaudojimą išsakyti nuomones, ir susirinkt pasikalbet, sugalvot kur kaip ka butu faina visiem det ir kurt?

Q4: *It is a problem mainly because they – we – spend most of our working life in the world of abstractions. We build crystal castles in the air and sometimes lose touch with the physicality of the medium other than pure thought.*

Q5: *Kodėl reikėjo fizinės vietos skaitmeniniame amžiuje? Nes mes visgi dar esame žmonės iš mėsos ir kaulų, be to, mus domino realūs fiziniai daiktai, ne tik programinė įranga. Žinot, aš kaip programuotojas galiu jums pasakyti – tas yra didžiulis dalykas padaryti daiktą savo rankomis, tokį, kur mamai gali parodyt.*

Q6: *This is why we embrace the analogue crafts and technologies -- ceramics, jewellery, metal casting, sewing -- at Technarium: they are, of course, influenced and improved by the new, digital, technologies. But they also let one stay in touch with the matter they work with.*

Q7: *Žodžiu, pankroko kelnytės mums jau mažokos.*

Q8: *Pradinė motyvacija visam tam -- labai paprasta ir natūrali.*

Tiesiog noras kurti žmonių bendruomenę, su kuriais būtų įdomu dirbti ir leisti laiką, kurti -- nes mes labai akcentuojame techninę kūrybą kaip tokį natūralų dalyką, stengiamės parodyti, kad mokslas ir technologijos yra gražu ir visai ne sausa

Šiaip iš esmės tai -- hakerių etika, jei esi skaičius tą Himanen'o knygą: noras kurti, veikti, dalintis, ir tai, kad rūpi, kas vyksta visuomenėje.

Q9: *Žinot, tas jausmas, kur nieko nebuvo, tada tu ėmeisi veiksmo ir pyst – yra. Tame kažko yra tarytum kaip nuo dievo – tas jausmas, kad gali dauginti dalykų pasaulyje – jis kabina ir veža. Toks beveik narkotinis kaifas, kaip kaip kaip.. kaip .. bet nenukrypkime.*

Q10*: Kūriniai yra paveikesni tada, kai jie yra aktualūs ne tik jų kūrėjui. Hakeris rūpinasi aplinka, kurioje jis veikia, nes veikti geroje aplinkoje yra tiesiog malonu. Hakeriui rūpi, kad jo kūriniai būtų prasmingi kitiems žmonėms, taip pat jis rūpinasi, kad kiti žmonės išprustų iki lygio, kur jie galėtų pasinaudoti jo kūriniais.*

Q11*: Mums labiau rūpi daiktai, kurie iš tikrųjų svarbūs pasauliui.*

Matėme, kad labai daug dalykų, kuriuos gamina save vadinantys makeriai, arba net ir žmonės, kurie kuria atviro kodo elektroniką (tokią elektroniką, kurios brėžiniai ir visos instrukcijos yra paviešinami), yra tokie pramoginiai iš esmės.

Na, žinai, laisvalaikis -- atsispausdinti skulptūrėlę su 3D spausdintuvu, išsiplauti figūrėlę lazerinėmis staklėmis, pasigaminti mirksiuką iš šviestukų.

Ir visa tai ok, fun and games.

Tačiau žinai, kaip buvo su atviro kodo programine įranga? ji dabar varo pasaulį: didžioji dalis interneto veikia dėl open source programinės įrangos, daugybė žmonių kasdien ja naudojasi (Linux, Firefox, netgi Mac OS branduolys iš esmės yra atviro kodo Unix operacinė sistema) .

O tačiau fiziniame pasaulyje daiktai, kurių reikia kasdien, yra arba brangūs, arba nekokybiški.

Aišku, su tuo labai susidūrėme, kai reikėdavo užsisakyti kokią nors detalę ar aparatą iš Kinijos.

Dėl to kažkaip ilgainiui suvokėme, kad tiesiog nėra gerų, atvirų, kokybiškų statybinių blokų gaminti daugeliui dalykų -- labiausiai elektronikai, tarkime, kontrolės sistemų, sensorių, maitinimo šaltinių, etc.

Q12*: Aplamai, čia yra Lietuvos ar post-sovietinių šalių problema: daug kas meistrauja, kažką krapšto, domisi, labai daug protingų, išsilavinusių žmonių, tačiau jie sėdi po vieną savo garažiukuose ar kambarėliuose.*

Ir nesidalina, nemato, ką daro kiti.

Vienas narys atėjęs pasakojo (jis visada meistraudavo, užsiimdavo elektronika, lėktuvų gamyba), kaip jo niekad niekas nesuprasdavo, nei merginos, nei šeima, o atėjo pas mus atsitiktinai ir pamatė, kaip visas namas tokių pačių, kaip jis.

O pamatėme, kad "žmonėms" tai reikalinga dėl to, kad vis kas nors užeidavo ko nors pasidaryti ar pasikonsultuoti, ar turėdavo klausimų.

Q13*: Aš noriu kad žmonės įsipareigotų vietai, kad įsipareigotų vieni kitiems, kad aš čia busiu, ir tave matysiu; tai nėra vietos komercializavimas ar formalizavimas, bet yra įsipareigojimas.*

Q14*: Tiesiog kartais žmonės su vienkartiniais projektais, ateina pasidaro ir tada dingsta. (pauzė) Aišku tai nėra gera praktika, norėtųsi kuo daugiau nuolatinių žmonių, nes tada ir plečiasi vis šita draugija.*

Q15*: Nes tokie žmonės, kuriems reikia tik patarimo ir pagalbos viename dalyke, tai jie nelieka ir neprisideda bendruomenėje, pasidaro, ko reikia, ir dingsta.*

Na dar yra keletas tokių, kuriems šiaip patinka idėja, patinka galimybė ateiti ir ką nors daryti, ir jie tiesiog kartu metasi nuomai, nors šiuo metu nieko per daug nedaro.

Q16: Na, kaip... mes ne dirbam... mes „esam" Technariumas!

Q17*: Nes mes labai akcentuojame techninę kūrybą kaip tokį natūralų dalyką, stengiamės parodyti, kad mokslas ir technologijos yra gražu ir visai ne sausa.*

Q18*: Žmonėms, kuriems įdomu technologijos (man į šitą žodį įeina ir mokslai), tačiau jie nežino, kaip pradėti, arba yra jau pradėję kažką daryti, tačiau sėdi izoliacijoje.*

Q19*: Šiaip galvojau, kad bus komercinis projektas (...), bet kai atsirado proga prisijungti prie Technariumo, pagalvojau kad bus naudinga tuo*

pačiu leisti kitiems žmonėms, kad jie dalyku tai, ką jie nori... (...) žodžiu, laboratoriniai prietaisai yra labai under-used, nuo jų naudojimo jie menkai genda, kadangi yra geros kokybės, ir tiesiog man yra gaila, kad jie stovi neišnaudojami. Tai dėl to pagalvojau kad bus labai faina jeigu atsiras kažkokių žmonių norinčių, kurie ateis, kažką pradės daryti, tirti savo naudai, ir galbūt iš to bus nauda ne tik visuomenei, kad kažkas išbandys savo jėgas, išmoks kažką, bet gal ir man pačiam bus nauda, kad atsiras kažkokių partnerių naujų, kad pasiūlys kažkokių idėjų žmonės. Tai ne tik geranoriška, nauda, bet ir monetizuojama taip sakant (šypsosi).

Q20*: Ne šventieji puodus lipdo, ne ten kokie ateiviai duoda informaciją apie tai, kad atsiranda naujos technologijos, bet viskas yra padaroma žmonių, viskas padaroma santykinai paprastais metodais. Tarkim, irgi vaisto kokio nors naujo suradimas yra pakankamai tiksliai išdėstytas procesas, kuris visą laiką kartojamas, ir ten nėra nei vienos tokios stadijos, kuri būtų apipinta kažkokias mitais, ar labai nepasiekiama. Tai tiesiog jie supras viso proceso paprastumą.*

Q21 *from* http://www.lrt.lt/radijas/laidos/1603.

Q22*: Na iš esmės, reikia pasigaminti baldu, bet namie nusibodo krapštytis, bet smagu, nes yra idėjų, bet nėra žinių (pvz., elektronikos), o čia galima pabendrauti, išmokti kažko.*

Q23 *from* http://www.lrt.lt/radijas/laidos/1603.

Q24*: Mes mokymais neužsiimam - jeigu degi noru kažką išmokti, tai tikrai rasi kas tau padės, kas pasakys, kad ne taip darai; visa tai vyks chaotiškai, neformaliai; jeigu norite kad jus „išmokytų“ eikite į Green Garage, o jeigu norite [mokytis] samurajaus principu, tai ateikit pas mus [juokiasi]*.

Q25*: Nebus taip, kad ateisi ir duos tau visas žinias – užves ant kelio, o paskiau jau pats turėsi išieškoti... ir tik kai bus kokia nors specifinė problema, tada turėsi susirasti specifinės informacijos apie ja. Nebus taip kad duos tau sukramtyta informacija, kad įrašys kaip su USB flashu. [šypsosi] Na, bet universitete užtat nėra taip, kad ateini pas dėstytoja ir sakai "duok man šita ir išmokyk šito dalyko", o Technariume gali. [juokiasi]*

Q26-27 *from http://www.lrt.lt/radijas/laidos/1603*.

Q28*: Labiausiai tai ir džiugina, kad visada atėjus yra progų kažko išmokti -- galbūt chemikas ką nors paaiškins, galbūt programuotojai kalbės apie kažką įdomaus, visada galima paprašyti, kad elektronikos žmonės padarytų kokį workshopą rūpima tema, ar nueiti pas stalius paklausti patarimo*.

Q29*: O, čia visai faina, jeigu būtų ir toks dalykas kaip laboratorija, nes visi kiti ten užsiiminėja kažkokias amatais, maždaug taip, o su chemija nėra kas daro, nors yra vienas vyrukas, kuris tuo norėtų užsiiminėti, bet jis dar toks yra, na, pinigų neturintis, tai tada jis neišlaikytų visos tos infrastruktūros. Ir galvoju tada, kad visai verta prisijungti, kadangi tuo pačiu, kad yra ir kitų erdvių, kitų mechanizmų su kuriais galima dirbti, tai yra labai patogu, nes kad ir dirbu tarkim su chemija, bet man prireikia kažkokio aparato, tai yra visos dirbtuvės, visa infrastruktūra, kad galiu tą padaryt vietoj. Arba susigalvoju, kad kažką tai*

man, kažkokio laikiklio reikia, ir galiu nuėjęs iš karto atsi-3D printint visa tai. Na ir pasirodė, kad labai daug galimybių iš to galima padaryt.

Q30*: Tai pirmiausia visi tie ,kurie domisi kuria nors apskritai iš Technariumo veiklu, nes ateina labai skirtingo profilio žmones, pradedant aludaryste, baigiant meninėmis instaliacijomis, skulptūromis, ir kai kurie susidomi būtent, būtent labai plataus profilio žmonės ir ateina. Bet juos visus vienija tai, kad yra smalsus ir linkę tobulėti.*

Q31-32 *from http://www.lrt.lt/radijas/laidos/1603.*

Q33*: Yra labai įdomu tie pirmadieniai, nes chat'ini, ir gali spręsti įdomia problemą... Namie nebūtų tokios problemos kaip nusprogusios lempos, [juokiasi] ir namie tiesiog sėdėtum ir YouTube žiūrėtum, o čia - daug įdomiau.*