Tallinn University

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Affordances of a learning scenario sharing tool LePlanner for teachers

Master's thesis

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Thesis has been supervised by PhD Kai Pata.

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Abstract

The master thesis study aims to describe a research on affordances of the LePlanner learning scenario authoring tool conducted with a group of teachers. LePlanner, currently in continuous development, was designed to help teachers with planning lessons and was repeatedly used in the teacher education at Tallinn University. The aim of the study was to find out how affordances are distributed across the interface of LePlanner in context of specific goals in perception of LePlanner users. Based on that an attempt is made to provide suggestions for LePlanner design.

The concept of affordances has been long a matter of active discussion within the field of human-computer interaction. Building on theoretical foundation from such fields of knowledge as ecological psychology of J.J. Gibson, distributed cognition, theory of sociotechnical systems, the author describes the design and results of a study.

A survey was built that included 3 test tasks for participating teachers. The participants evaluated strength of affordances for each task and related interface elements with them. Based on the survey data suggestions to inform the ongoing process of design are provided. Future work may concentrate on exploring real usage data in order to find correlations between affordances as they are perceived by users and ways the software is really used.

Eestikeelne kokkuvõte (Summary in Estonian)

Käesoleva magistritöö eesmärgiks on kirjeldada õpetajate seas läbi viidud uuringut selgitamaks välja LePlanneri õpistsenaariumite töövahendi lubavusi. Jätkuvalt parendusfaasis olev LePlanner on disainitud aitamaks õpetajaid tundide planeerimisel ning seda on korduvalt kasutatud Tallinna Ülikooli õpetajahariduse valdkonnas. Uuringu eesmärgiks oli välja selgitada, kuidas LePlanneri kasutajad tajuvad lubavuste jaotust LePlanneris oma eesmärkide kontekstis. Töö tulemusena valmisid soovitused LePlanneri disaini osas.

Lubavuste kontseptsiooni üle on inimese ja arvuti interaktsiooni valdkonnas pikka aega diskuteeritud. Tuginedes teoreetilisele raamistikule valdkondades, nagu J.J. Gibsoni poolt välja töötatud ökoloogiline psühholoogia, jagatud tunnetus, sotsiotehnilised süsteemid, kirjeldab töö autor disaini ja uuringu tulemusi.

Töö käigus loodud uuring koosnes kolmest testülesandest õpetajatele. Uuringus osalejad hindasid lubavuste tugevust iga ülesande puhul ning sidusid selle liidese elementidega. Uuringu tulemuste põhjal on koostatud ettepanekud disaini osas. Tulevased uuringud antud valdkonnas võiksid keskenduda tegelikele kasutusandmetele, et välja selgitada kuidas on seotud tajutud lubavused ning tarkvara tegelik kasutamine.

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The author thanks the supervisor of this master's thesis Kai Pata for always having time to spend on perfecting the study and being remarkably patient and helpful. The study would not represent what it is without the absorbing (and complex) materials of the supervisor's research and blog posts which have encouraged deeper understanding of the ecological psychology ideas.

The author would like to express gratitude to the teachers who participated in the survey. A thank you is reserved for professor David Lamas for steering it in the right direction and precious notes and recommendations in the beginning of this study. Finally, Romil Rõbtšenkov (the creator of LePlanner) contributed a lot to this work by providing help with the application and survey data and being ready to give a good advice.

Table of contents

1. Introduction

This master study aims to describe a research conducted as a part of master thesis. The research was framed within the Educational scenarios class for teachers held in the Autumn 2016 semester at the Tallinn University. The aim of the study was to find out which affordances are considered to be most and least employed by users of an online scenarios authoring tool LePlanner. An attempt was made to track and analyze the affordances usage picture projected by LePlanner users.

Today a plethora of digital tools of different purpose (standalone services, learning environments, massive open online courses — MOOCs) or technical nature (such as web, computer, mobile software) allow teachers to diversify subjects taught to students and make them much more interesting and catching attention while spending much less time on preparing learning content than in the past.

They also give teacher community the power to flexibly bend and enrich existing teaching strategies (based on individual or group tasks with few interactivity) or author totally new ones.

The spectrum of different digital assets which are employed when preparing lesson plans is also very wide. As educational software progresses and the range of assets gets diversified there appears an understanding that this wide array of available tools cannot always help to enhance quality of teaching. Some effort should be invested into organizing and making sense of those for each course, school, teacher-specific learning goal. Thus a certain need might be felt for a tool that would improve the quality and standardize teacher's workflow.

This task is being solved by a software called LePlanner developed by Romil Rõbtšenkov at Tallinn University as a part of a master thesis project (Rõbtšenkov, 2016). LePlanner was created with involvement the teacher community in the course of a participatory design research as a part of Creative Classroom project that was ongoing in Tallinn University (Pata, Beliaev, Rõbtšenkov, Laanpere, 2017; Hoić-Božić, Laanpere, Pata, Franković, Teder, 2016). It is built as a web application that provides teachers an environment where they can plan and build visually rich learning scenarios. Such a scenario can be later used to organize and balance out educational routines, keep track of learning resources etc. An important part of the LePlanner environment is that it was ideated as a shared space for communication and collaboration between teachers, augmenting the evaluation and feedback of different scenarios and creating an ecosystem for teaching professionals that goes beyond individual approaches (Vangrieken, Dochy, Raes, Kyndt, 2015). In this ecosystem users provide mutual support for each other in the same way as their goals are supported by the technical part of the software. LePlanner thus represents an example of a **sociotechnical system** — a system that works in between social and human-computer interaction.

Even the most thought out and well developed new technologies while providing some useful services to users normally require them to learn of new practices and skills. This involves people into constant decision making process regarding usage of software and its applicability to their specific goals (Gaver, 1996). LePlanner was tried out during two semester long workshops in spring and fall of 2016 with teaching professionals in Tallinn University and gained some popularity among them. There was no research on its efficiency yet. A complex sociotechnical system may not be easy to evaluate from the point of view of opportunities it gives to its users, and that is the **problem** that is tackled in this master study, offering an affordance based solution to it.

Affordance is a term coined by Gibson in 1977 (Gibson, 1977) that has a long and confusing history (Torenvliet, 2003) and has had a particularly strong impact on the development of HCI (Dourish, 2001). Originating from psychology, the term crosses the borders of HCI/HMI, philosophy, design theory, learning sciences and other fields such as health and sports. Affordances of a system reveal how its users actually conceptualize and enact it (Pata et al., 2017). A sociotechnical system may possess a number of affordances which demonstrate the level and the range of its functionalities as perceived by its users in relation to its actual usage (Pols, 2012). In this research the author looks at what the LePlanner software affords to its users from their perspective hoping that this may contribute to the goal of evaluation this and similar digital tools in future.

The research question of this study therefore is how the affordances are distributed across the interface of LePlanner in context of specific goal sets, as perceived by LePlanner users. Humans look for any patterns that could potentially be applied to other knowledge sharing and learning tools. The study is explorative in nature, however, it was hypothesized that studying affordances as they are perceived by users can at least suggestively aid design of a digital learning tool.

Based on the study conducted within this thesis a conference paper was created for the iCALT'2017 conference (Pata et al., 2017). The paper was reviewed by three reviewers. It was valued fairly or highly with some minor comments and accepted to the conference.

1.1. The rationale for selecting the topic

The first PhD of the author was devoted to how interface elements of newspapers sites are organized by unified visual design model. The initial interest in affordances has appeared when the author was preparing a semester long workshop for design students at Moscow State University. The first insight to this topic was given by works of Norman (Norman, 1988). Studying affordances of an actual software tool based on perception of real people is a convenient possibility for advancement in this topic and applying it in my future research, professional UX practices, and teaching work.

1.2. Thesis structure

This thesis consists of 3 chapters.

The first chapter, **Literature review**, comprises an extensive literature overview of such concepts as affordances, ecological niches, sociotechnical systems, and distributed cognition as related to the learning design domain. Although the affordance concept takes its roots in the discipline of psychology, it and the related concepts have been long welcomed and discussed in a highly vibrant fashion in the human-computer interaction (HCI) community.

The second chapter, dedicated to research **methods**, deals with the survey conducted within Tallinn University. It explains the details of the research done, namely experimental design, its methods, sample and instrument, as well as insights to the data analysis.

The final chapter is devoted to the **discussion** of the results in light of literature on affordances.

The main body of the thesis is accompanied by several appendices.

2. Literature review

2.1. Theoretical frameworks

The research basis for this work is supported by several theoretical frameworks. Among these are ecological psychology of J.J. Gibson, the theory of sociotechnical systems, and the distributed cognition approach.

2.1.1. Ecological approach to cognition

One of those is ecological psychology in how it was framed by J.J. Gibson. The views of Gibson were formed under a variety of influences — namely those of E.B. Holt, W. James, M. Merleau-Ponty, and others (Heft, 2001). Dourish (2001) notes that ecological psychology is concerned with organisms living and acting while being immersed in the world, studying "knowledge in the world" rather than "knowledge in the head". As (Reed, 1996), applying Gibson's principles to animal biology, puts it, ecological psychology provides a look at behaviour by reversing the focus of the ecology field on how animals activities affect environment. This means that environment forms and organizes behaviour too. One way in which this linking is established is by means of how nature affords something to an animal so that it could use it for satisfying its needs. In the same fashion as tree trunks afford better view for small predators such as lizards and thus organize their both short-term and long-term behaviour, features of physical or digital environment determine the activities of its inhabitants or users. According to Heft (2013), this take is somewhat different to a more traditional "mind mirrors nature" position in psychology in that it postulates not the duality but reciprocity of animal and environment, shifting also focus away from an individual. Ultimately, as Heft assumes, the essence of the ecological approach is that it is relational conceptually and not individualistic.

Ecological approach as seen from the original gibsonian perspective does not make any pronounced distinction between humans and other animals (Kaptelinin, 2012). The ways in which keyboard affords typing for a person and darkness affords hunting for a fox are essentially the same. Gibson warns against making distinction between cultural and natural environments (Gibson, 1979), and its the world's diversity itself that makes up for the variety of ways in which organisms adapt to what encircles them. There is a strong evolutionary component to ecological approach: for example, Bardone (2011) suggests that humans outperformed other species in occupying shared environments thanks to their abilities of cognitive engineering. The use of artifacts has a special place reserved in this framework of ideas: better technology affords better cognition, and better cognition is a matter of design (Harris, 2012).

It is important to remember that the human ecosystems are intertwingled with the cultural background and other social features (Pata, 2009) which are kept in the form of "traces" in roughly the same fashion as termites leave their pheromones on pieces of mud and build up the ecological niche accordingly in direct way (following the example of the stigmergy phenomena by Susi and Ziemke (2001)): "The interrelations between communities, the environment and the culture left there by people - the traces of meanings and the traces of activities - are important in the ecological framework".

2.1.2. Distributed cognition

Distributed cognition is a theoretical approach offering research frameworks for studying cognition as offloaded onto environment. As Stotz (2010) notes, it stands in one row with recent approaches to cognition that "look beyond ‘what is inside your head’". Hutchins (1995, p.365) was one of the researchers to support the idea that human cognition is not modular with perceptual, motor, and other cognitive processes divided. Instead it propagates itself into world around us proactively utilizing it (namely tools, other individuals and so on) directly and leaving internal or external residue. Roughly at the same time Zhang and Norman make a similar conclusion that the system operates with representations that are both internal or external (Zhang and Norman, 1994). Thus, as Hutchins posits, the same processes that change mind change environment as well (Hutchins, 1995, p.374). Hollan and associates (Hollan, Hitchins, and Kirsh, 2000) follow this line of thought suggesting that perception of external world by humans is formed by interactions with it in which internal and external resources are intertwingled. The internal resources mentioned here are, for example, memory and attention, and the external resources are presented to us by the whole range of action possibilities in the world (or rather "a world" taken in reference to actor goals). Therefore cognitive system can be viewed as a set of packages and resources where it's not only the brain that participates in activities (Clark & Chalmers, 1998, p.14).

Bardone shifts the focus to environment contending that "human cognitive system is shaped by external resources and representations" (Bardone, 2011, p.58) instead of internal mental operations. In fact, "almost all human performances are hybrid in the sense that they are brought about by various interplays between individuals and external objects". According to Bardone (2011, p.XI), humans build externalized cognitive structures around themselves (ecosystems) to enhance decision making and overcome our cognitive limitations. Humans are powerful "eco-cognitive engineers" as we not only use the cognitive possibilities that are available naturally for us but also seek out the "chances" (see 2.2.1.2) kept in the environment, which leads us to manipulating and rebuilding it. This means that a human would use any chance in the environment to transform his/her niche and adapt it to a goal. The same sort of cognitive structure is represented by an interface (Magnani & Bardone, 2006) which mediates relation between users and application.

2.1.3. Sociotechnical systems theory

Sociotechnical system (STS) is a concept arisen to explain how systematic integration of human-computer interaction and social communication works (Herrmann, 2009; Tammets, Laanpere, & Pata, 2013). We can call the users of the system its actors. Sociotechnical systems theory suggests that it is important to consider individual actor behaviour within a system in the context of network of relationships between people. Here how a person acts depends on his/her relations to other persons and artifacts within the system.

Another perspective is given by Pata and Bardone (2014), who focus on the concept of learning services as a kind of digital "organisms" that exist and function in symbiosis with learning content producers and digital content. Users of a sociotechnical system create those services and utilize them at the same time. It can be reiterated that "variety of mutually communicating learning services in MOOC ecosystems provided by all MOOC participants facilitates their mutual awareness and participatory surveillance" (Pata & Bardone, 2014), thus variety of kinds of interaction in a sociotechnical system fosters further activities as well.

Vatrapu (2009) uses the notion of technological intersubjectivity to address affordances in learning oriented sociotechnical systems. Technological intersubjectivity is essentially about "interacting with people via technology"; it represents a convenient concept for describing how a sociotechnical system works. Within this focus affordances of an STS are relational properties of the system depending on specific situation. He also sets up a term of sociotechnical affordance as dual sided, capturing both types of interaction in an STS — interaction between people and interaction with technology. As Vatrapu posits, there are four aspects of affordances in sociotechnical system, which are action taking possibilities and meaning making opportunities appearing in between user and technology — with respect to learner competences from one side and technological capabilities of the system from another.

A complement to the concept of sociotechnical system is the idea of **way of life** (Rietveld & Kiverstein, 2014) meaning globally taken set of skills and practices for each person in society as a whole. The idea of way of life expands on the concept of animal by Gibson (Gibson, 1979, p.3) and could be seen as applicable to the whole variety of different social contexts characterizable around profession, age, habits etc. (e.g. there could exist a way of life of gardener, kid, food lover). In Rietveld opinion, those contexts are not separated, they may overlap and contain each other — for instance, there is a certain way of life for all humans as opposed to a way of life of an insect, and there is a certain way of life for women, office workers, people of Chinese descent, and so on. As he assumes, all of those individual but socium-related aspects of a human being are involved in highlighting this specific affordance. It is, in a generalized fashion, one way to connect the social subsystem of an STS to affordances concept. Namely it could offer a convenient clarification for why groups of people may see affordances differently while perceiving the same object and pursuing the same goal in mind. Therefore Rietveld proposes to integrate this idea into the standard definition of an affordance.

2.2. Affordances and ecological niches

2.2.1. Views on affordances

2.2.1.1. The concept of affordances in ecological psychology

As many indicate (see for example Chemero, 2003), there is no lack of expert opinion on affordances concept and there exists a degree of variation in understanding it. The focus may range from ontological (e.g., Turvey, 1992) to epistemological (e.g., Barab & Roth, 2006), as well as from a philosophical (e.g., Rietveld & Kiverstein, 2014) to more work or design practice related position (e.g., Vyas, Chisalita, & van der Deer, 2006). However the term was coined in its initial form by J.J. Gibson (Gibson, 1977).

As the basis for the concepts of Gibson a materialistic perspective of perception is considered (Turvey, 1992) though not in a mechanical sense — it is true that for example physical objects of the world or perception-aiding biological systems inside us exist, but their existence alone and physical nature doesn't help much to explain the link between animal and environment as an interactive system (Adolph & Kretch, 2014).

According to Gibson (1979), environment provides certain information to animal through the so called ambient optic array. Animal is able to isolate so called invariants within all the information it gets from nature at a point in time. Invariants are permanent perceivable features of environment that form spatial or temporal patterns. As put originally by Gibson, **affordance is combination of invariants that are taken in reference to an animal**, or those that are related to motives and needs of an observer and a physical world at the same time.

Gibson made a strong emphasis on the notion that perception of affordances is direct — there is no layers of raw information analysis and no transformations of physical data into mental representations, as it was considered in earlier theoretical frameworks such as cognitivism. Animals do not abstract what they perceive — they see a possibility for action and then act upon it (we do not rationalize the size of a bear met in the woods in order to decide to run from it).

Affordances are not subjective phenomenal qualities nor they may be considered objectively perceivable by every animal (Torenvliet, 2003) as the popular among design practitioners point of view promoted by Norman (1988) posits. They have relational character, meaning that they are perceived on a situational basis — when there is a goal available for a perceiving animal that they can help with achieving. That wouldn't mean that they do not exist when an animal does not have a task to achieve that could involve them — a car will always afford running over a pedestrian even if the latter does not perceive it.

Affordances therefore are not value free (Kaptelinin, 2012). According to (Pickering, 1999), an act of discovering affordance equals an act of obtaining an inherent meaning. This meaning is always goal-related and can be articulated (though it does not always happen). Affordances can serve either for resolving a task or avoiding a problem. That leads to the idea that an affordance can be positive or negative depending on animal itself. For instance, darkness affords hunting for a predator but at the same time affords being caught to the same animal by a predator of a higher order. As an example which refers more to the field of HCI, a button on a nuclear plant control panel affords releasing toxic gas with saving lives or equally killing personnel as the result.

The observation that affordances themselves can be organized into structures based on actions can be found in other research too (Pols, 2012). Here lies a significant problem with describing affordances: they can be traced to different actions. Pols offers his classification (serving at the same time as a naming model) based on the level of directness/immediacy of the action-affordance link: he presents as types of affordances opportunities for manipulation, for effect, for use plan, and for activity. Another classification inspired by the activity theory was proposed by Vicente and Rasmussen (1992). It is grounded on assumption that levels of cognitive control (which in opinion of Albrechtsen, Andersen, Bødker, and Pejtersen (2001) can be traced to affordances) can be organized on at least three levels. "Why" corresponds roughly to the final goal of an activity (for walking a dog it would be to get a rest for yourself and the pet), "what" is about how to define the low level affordance for specific enacted activity (locomotion as what the street surface affords), and "how" is signifying the means of conducting the activity (walking).

Finally, learning is an integral part of the ecological psychology ideas compendium, as to flexibly act upon affordances of environment and interact with it an animal needs to learn. Learning may serve as the mechanism for reproducing the useful behaviour variations in time that are aimed at developing new sets of affordances (Bardone, 2011, p.100).

2.2.1.2. Development of the affordances concept as applicable to the field of HCI

The affordance concept in HCI has had a long history of confusion and varying interpretations with "its meaning bifurcated wildly" (Torenvliet, 2003). There were also several attempts to offer a classification of affordances based on different premises, for example, communication-based or ontological.

Norman was notably the first to introduce the term to the HCI community (Kaptelinin, 2012). In his research he has been writing that affordances are perceived properties in an object (Norman, 1988; Norman, 1999). In Norman's opinion, the practical usefulness of the term could be reaped if the meaning referred to graspable properties that can be easily designed for. He was followed by one of the most influential authors in the field of usability and interface design, Alan Cooper, who regards affordances as being simply a perceived experience-based feature of a designed object (Cooper, 2014, p.312).

There was a lot of critique of this approach (McGrenere & Ho, 2000; Torenvliet, 2003; Kaptelinin, 2012). As already Norman himself indicates (Norman, 1988), his understanding deviates from the gibsonian point of view. Later researchers (McGrenere & Ho, 2000) showed that for Gibson affordance had no relation to an actor's prior experience, and that his interpretation posits the necessity of distinguishing information that specifies an affordance and affordance itself. For design in HCI the gibsonian concept of affordance is useful because it can be attached to user goals as a necessary relation rather than pointing to the need of maintaining symbolic meaning in design elements assumed by Norman's position.

Gaver (1991) did a significant contribution to the development of affordances concept inside HCI curricula. As Dourish (2001) notes, he aimed to integrate the ecological approach systematically in interaction design. He offered a view differing from Norman's: he argued that affordances do exist independent of perception (which is more in agreement with Gibson's ideas). He also declared the notion of affordance as being useful for design in HCI, stating that design may suggest an affordance. In his opinion, perceiving affordances does not require any mediation such as experience or mental calculation.

Gaver also proposed three categories of affordances as applicable to interface design and in relation with available information on the invariant suggesting the affordance. Perceptible affordances correspond to the information that is provided. False affordances can be discovered based on misinformation (Gibson also mentioned that this might be a case in his work (Gibson, 1979), and this line is followed much later in the research by Xenakis and Arnellos (2012) and Pols (2012) who explain the cases of miscommunication between designer and user). We can also indicate a hidden affordance if no information is provided on whether an invariant is interactable. Therefore, it is in the best interest of designer to make sure affordances of a designed artifact are perceptible.

Ecological psychologist Turvey (1992), building up on the Gibson's legacy, was the first to offer formal definition of affordance. He thought that affordances are dispositional properties of other properties that are manifested only when paired with actualizing circumstances and **effectivities** of actor. Effectivities are essentially abilities affording a certain action and complementing a certain affordance. As Chemero (2003) notes, Turvey considered affordances non existing in absence of an effectivity or animal, or actualization. Some later debate was initiated by Turvey's paper. For example, Stoffregen (2003) argued that actualization is not a necessary component of the definition of affordance, positing that in any given situation, an unlimited number of affordances exist. In his opinion, it is the **intention** of an animal that actualizes an affordance. For example, learning motivation appears as an intention and focus on specific system resources in coupling between goals and affordances (Pata & Bardone, 2014). Vatrapu (2009) utilizes the term appropriation for describing a situation when an affordance that was yet independent of actor becomes relevant to him in a context of a specific goal (that is, it becomes "visible" because it becomes relevant).

The effectivity term gets further attention from Michaels (2003). She makes a point about dynamic nature of affordances — actualizing one affordance can actually change the effectivities and consequently reveal other affordances to user. This may be especially through in even slightly complex applications which may consist of several steps for a task, each extinguishing an affordance network (see 2.2.2.3) and instead actualizing another one.

For Michaels, perceiving an affordance means for an actor that he/she gets prepared to act. Recognizing an affordance of a button means, in agreement with Gibson's conceptual framework, that the user is ready for executing action. In this sense, designing for specific affordances can be an optimal and the quickest way to guide him/her to action (as compared to designing for, say, symbolic meanings enabled via metaphors, for example).

Another position is held by Reed (1996) who made a point about evolutionary nature of affordances and believed that they are born out of "selection pressure" of choosing resources. Unavailability of resources also can cause selection pressure for animals (we might connect this idea to the notion of "negative" affordance by Gibson). As far as this position is of concern for HCI and the design of sociotechnical systems in particular, both absence and presence of information leading to discovery of affordances will form the cognitive niche and shape the behavior of users. For instance, the absence of shortcuts to some functions or other actors (taking an example of a social service such as MOOC) could affect how often people use a product. It might be inferred that constraints of a system play a role as important limiting users to form a niche in ways envisioned by the system designer.

Later developments in understanding affordances are pursued by Bardone (Magnani & Bardone, 2006; Magnani & Bardone, 2008; Bardone, 2011). He suggests that affordances are "cognitive chances" given by environment that are sought out by people in order to strengthen their decision making. "Humans can be considered chance seekers because they are engaged in building up and discovering possibilities to uncover new valuable information". Chance in this context is a bit of information that is stored externally and has to be picked up to be used (Bardone, 2011). Utilizing chances is how animals modify their niches: "animals can “modify” or “create” affordances by manipulating their cognitive niches" (Magnani & Bardone, 2008).

Another concept that Bardone uses is the information or environmental cue. This term allows to highlight the physical features of an artifact relevant that may eventually communicate affordance to pick up. This is compatible with the view of Gibson who did not use a theoretical apparatus differentiating between the kinds of information and rather thought of information in terms of ambient optic array and combination of invariants arising from it (Gibson, 1979). The process of "parsing" information cues from the environment in relation to goals is called "attunement" by Bardone (2011). This process is non linear and is based on continuous interplay between the environment and actor. This means that affordance is not immediate in setting a user to act in a given ecosystem; there may be an element of playing with and trying out different options before.

What is interesting is that Bardone also diverges from the Gibson's idea of direct pickup in stating that there is a need to account for higher order internal resources such as thinking and learning. This can be directly applied to the field of HCI: "in designing an artifact to the aim of properly and usefully exhibiting its full range of affordances I have to clearly distinguish among two levels: 1) the construction of the utility of the object and 2) the delineation of the possible (and correct) perceptual information/cues that define the available affordances of the artifact." (Bardone, 2011).

2.2.2. Affordance literature findings

Summing up, the literature review can be concluded on affordances with these findings that will serve as the foundation for the research:

1. Affordance represents a relation in the actor-environment system.

2. Affordances exist in unlimited number at a point in time but they need to be actualized to become real for an actor.
3. Affordances are actualized in a presence of a goal.
4. Intention serves as a tool for coupling goal with affordance.
5. Niche is a set of affordances.
6. There are at least two useful understandings of the niche term — ecological and cognitive niches. The latter may be confined in the first; cognitive niches build up dynamically as animal gets attuned to specific ecological niche (which may represent an sociotechnical system).
7. The process of picking up the information cues is called attunement. Attunement however consists of a dynamic interplay between various aspects of environment and internal and external representations of a person It also deeply depends on culture-related factors and cognitive niche built around a specific situation.
8. The meaning of an affordance is obtained when the latter is actualized (though usually it is not articulated internally).

The *figure 1* shows how an information in environment can lead to action through discovering and actualizing an affordance.

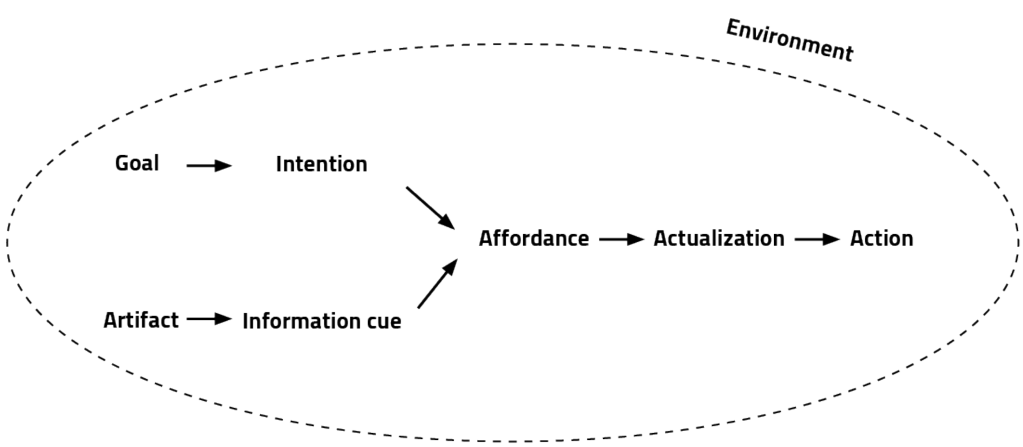

Figure 1. The process of actualizing affordance

2.2.2.1. *Affordances in a sociotechnical system*

Many researchers (Vatrapu, 2009; Pols, 2012) maintain that affordances should be considered part of a sociotechnical system. Pols (2012) writes that affordances should be considered in context of sociotechnical system on several levels. He claims that there are four kinds of descriptions that may apply to an affordance in a sociotechnical system: how the artifact can be manipulated, what are the reliable effects of the action, what can be done (achieved) with the artifact on its own and what can be done within the sociotechnical system thanks to the artifact.

Gaver (1992), who could be the first to consider affordances in the context of social-enabled HCI applications, stated that affordances is a valuable tool for describing collaboration. According to Heft (2011), affordances are deeply embedded in social processes. Pata and associates (2017) define affordances informally in relation to the concept of sociotechnical system as "emerging user-defined interaction niches with the system in particular goal-directed task contexts".

2.2.2.2. *The structure of an ecological system — niches*

For his ecological perception theory Gibson borrows the concept of niche from ecology. Niche is about how an animal lives and cannot be specified without relation to animals that inhabit it (Gibson, 1979). Animals are not static actors, they proactively change the niche they occupy. For example, Odling-Smee and associates (2013) conceptualize the activities of animals interacting with their immediate environment as "niche construction".

The niche construction idea is found in a much wider ongoing debate on how inheritance works (Laland et al., 2014). The changes that animals cause to their environment are inherited in the same way as genetic code, with one major difference that they affect future generations not internally but externally, through the changed environment and therefore conditions for a way of life.

According to Gibson and later researchers, including in the domain of HCI (see for example Albrechtsen et al., 2001), ecological systems or niches represent sets of affordances. There are certain niches for each kind of animal, as we may possibly also say, for each way of life (Gibson, 1979). A niche can be said to be occupied if what it offers has been taken advantage of (Gibson, 1979), meaning that its affordances have been revealed. The concept of niche was applied to cultural environment by Gibson himself. We can consider a designer's job creating a virtual ecosystem where invariants of the work system are designed through user interface in the same way as the invariants of the real world (Albrechtsen et al., 2001).

We may consider useful also the concept of cognitive niches grounded in the evolutionary biology (Tooby & DeVore, 1987; Clark, 2006; Pinker, 2010). Cognitive niche refers to abilities of an animal to design new roles for itself on the fly in order to succeed in the environment they live in. Humans' usage of tools, learning and creative thinking is a important advantage over other organisms which allowed humanity to change the ecosystems which it inhabited. As Pinker notes, "cognitive niche differs from many examples of niches discussed in biology in being defined not as a particular envelope of environmental variables (temperature, altitude, habitat type, and so on), nor as a particular combination of other organisms, but rather the opportunity that any environment provides for exploitation" (Pinker, 2010). For the HCI research, this means that any system needs to be designed in a way that provides many opportunities for appropriation and taking advantage of it, and that this system should probably be as ready as possible to be utilized in unpredicted ways. Users of such a system have their individual goals as well as they share common collective goals. This means that they have their own cognitive spaces/niches as well as common, distributed cognitive niches.

2.2.2.3. Affordance networks

One concept useful in relation to learning domain is affordance networks. It was explored for instance by Barab and Roth (2006). As niches, they represent a kind of affordance grouping, however in this case affordances networks are directed by one set of goals and distributed across time and space. They emerge especially during structured learning process. Each affordance in a network thus illuminates some aspect of knowledge. In the context of this master study, not only LePlanner interface presents possibilities for discovering affordance networks related to one goal or task, but user content created by learning facilitators can be considered making other affordance networks available to other users as well (though to avoid confusion we will concentrate on the affordance network that emerges from the software usage and not appropriation of its content). It is possible to design for specific affordance networks, designing external resources and directing internal ones in a system.

Affordance networks may serve as a good conceptual tool that allows not only group affordances by tasks or goals but to track how different affordances sink and emerge over time as context changes. An affordance taken out of its network loses its ability to power a complex knowledge. In this study we may take temporally (a task is given to each user for a period of time) and spatially (a task normally comprises the same set of software screens) integrated affordance networks as corresponding to each task given to the users during the course of the survey we undertake.

We will expand on how these frameworks and their main concepts apply to the research below.

2.3. Authoring tool LePlanner

LePlanner software, its goals, and the process of development is described thoroughly in the master thesis of Romil Rõbtšenkov (Rõbtšenkov, 2016). The main goal of the software is to solve the problem of lack of planning digital tools for teachers. Namely "it enables relating competencies" for its users (Pata et al., 2017). LePlanner is pretty mature and rich in functionality considering relatively short timeframe of development. It is also continuous as the tool gets constant updates[1]. LePlanner is used already by people from Estonia, Russia, Finland, Bulgaria, and so on. It has been used in a variety of learning

[1] See the project development page at https://github.com/romilrobtsenkov/leplanner-beta.

projects (such as Creative Classroom of Tallinn University) or courses for teachers (Digital Turn) in Estonia and abroad.

Technology-wise, LePlanner is implemented as a web application built with Node.JS framework. There is documentation on the development web site which allows to install the application in local environment and as such have several working copies of it; this could prove useful in future for conducting experiments.

The activities within LePlanner can be categorized in this fashion with relation to users' goals:

1. scenario searching and filtering;
2. scenario creation, editing, and forking (copying with subsequent editing). This includes accumulation and presentation of digital resources used within a learning scenario;
3. social activities — commenting or favoriting scenarios, subscribing to users' scenarios.

The rationale for the need in this tool is that nowadays a large number of tools for teachers is present but they mostly help with collecting digital artifacts for later usage in classroom or presenting them to students. In the time when the amount of different teaching ideas, techniques, artifacts accessible to teachers is overwhelming, organizing per-class learning content in an easy-to-digest-and-share package is a very relevant task but still mostly unsolved for many members of the community (Mor & Hernandez-Leo, 2013). That could encourage dissemination of teaching best practices, "open-source" it to the teachers community allowing anybody to reuse not only teaching materials but also the whole lecture plans.

LePlanner encourages a knowledge-based ecosystem to appear within which users not only can share content created by them but also remix and repurpose it (Pata & Bardone, 2014). Thus scaffolding for new knowledge is provided not by third party but by the users themselves through the sociotechnical services blueprinted by the system. The possibility to reuse and remix existing content is really important for teachers who constantly need to adapt to concrete demands and changes in student audience (such as level of education or specialty being learned), school requirements and so on.

2.4. Learning scenarios

The main unit around which the ecosystem of LePlanner is built is a learning scenario. A learning scenario consists of learning activities which may include learning objects (Simon, Aram, Van Assche, Anido-Rifon, & Caeiro-Rodriguez, 2013). It can describe roles, activities, resources, tools, and services required to perform each activity (Pata et al., 2017). Using the scenario metaphor allows to account not only for objects but also for actors, different stages, and other actively utilized components of the plan. Learning scenarios in LePlanner are digital artifacts themselves; they are shareable, copiable, and editable.

A learning scenario as a digital convergent product can be represented in different formats — as text, raster image, PDF, vector based scheme and so on. It is composed from many elements describing in general a typical learning activity in a flexible way (Rõbtšenkov, 2016). A number of meta attributes also belongs to a scenario, among the most important its learning outcomes which are to be followed through while designing a scenario. An activity has some attributes to be described by user of the system, but the main attention here is on digital resources that have multiple properties such as display device, resource and conveyor (meaning, for example, the software for classwork execution and specific example to be used by students, accordingly), level of co-authorship and so on. The concept map on *figure 2* (Rõbtšenkov, 2016) explains graphically all the components of LePlanner structure.

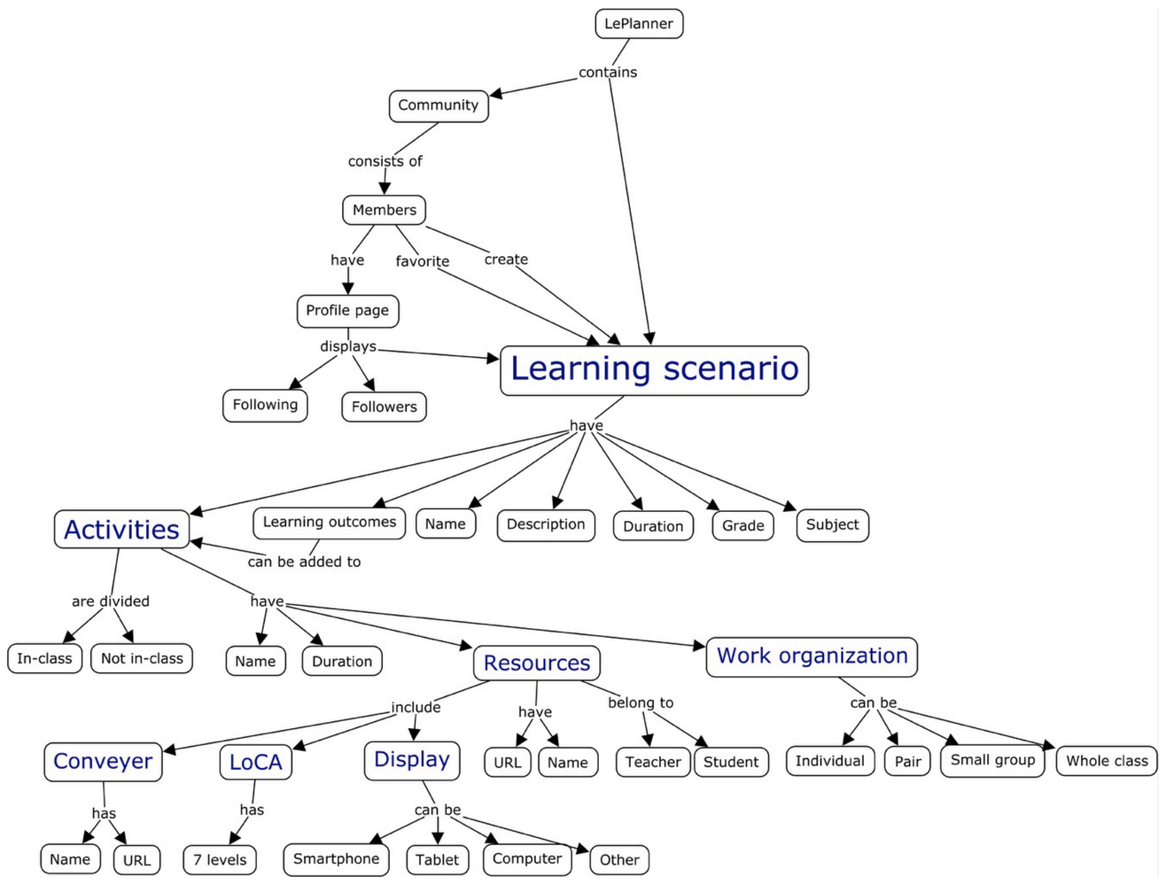

Figure 2. *Concept map describing LePlanner structure (Rõbtšenkov, 2016)*

The learning scenario is meant to be used directly in classroom conditions (Rõbtšenkov, 2016). The default image format of scenarios in LePlanner helps to do quick overview of the activities planned and is more easily understandable by others than text format that can be quite hard to digest. The color coding should help most of the users to differentiate between various learning objects (Rõbtšenkov, 2016).

2.5. LePlanner as a learning design tool

Learning design is a practical field dedicated to how tools can support teachers in designing courses that is usually defined via pedagogy and not technology (Dobozy, 2013). It is also meant to facilitate sharing the design knowledge among teachers (Masterman, Jameson, & Walker, 2009).

There have been some both theoretical and technological attempts to formalize learning design experience in application to practical teaching process oriented goals, as compared with more prominent usage of student oriented e-education frameworks and tools such as SCORM and Moodle. Varied conceptual foundation has been proposed for learning design tools. For example, activity theory (Masterman, 2008) has been suggested for this purpose, as well as Computer Supported Collaborative Learning (Hernandez-Leo et al., 2005) or constructionist learning (Laurillard et al., 2013).

IMS Learning Design (Dolonen, 2006) is the most noticeable example of a formal technical specification for describing pedagogical activities. Some tools were developed utilizing this specification (such as LAMS which is "inspired" by IMS LD[2]) as well as others based on different premises. A tool similar to LePlanner is the Learning Designer[3] by London Knowledge Lab. It focuses on supporting creation of learning scenarios structured with different levels of interaction, used resources, and so on (Bower, Craft, Laurillard, & Masterman, 2011). There are others as well, such as the Composer[4] or CopperCore[5]. Many tools were found not satisfying various efficiency criteria though (Mor, Brock, & Hernandez-Leo, 2013).

LePlanner as a learning design tool was created in an attempt to overcome the deficiencies of these tools building upon their experience (Rõbtšenkov, 2016).

[2] See the LAMS website — https://www.lamsfoundation.org/about_lams.htm.

[3] See the project site http://learningdesigner.org.

[4] The project site is located at http://itec-composer.eun.org.

[5] See the project web page at http://coppercore.sourceforge.net/.

2.6. LePlanner as a sociotechnical system

LePlanner can be considered an example of a sociotechnical system (STS). According to Maguire (2014), sociotechnical systems are composed of several elements making up the structure of a STS:

1. The presence of a collective operational task meaning that the system actually functions to achieve its specific goals.
2. There are two subsystems that a sociotechnical system consists of; social subsystem relates to people working in the system and technical subsystem refers to technologies that make it up. The idea of having a separate subsystem for complex social interrelationships is in a basic way mentioned already in Gibson's work as a reciprocal connection between two animals, for example, buyer and seller.
3. Sociotechnical system must be open which means that it needs to adapt to emerging environmental changes. This aspect is really important in light of the ecological approach (see 2.2.1.1) to design because it views a system under the evolutionary focus.
4. A sociotechnical system also stays for the whole period of its lifetime in an unfinished state. This idea is very compatible with many modern technologies of continuous development that assume that system design is a never-ending cycle of reviewing and refining activities.

LePlanner can be considered an example of a sociotechnical system. It conforms to the four elements of an STS noted above in the ways that we will now describe.

1. The work in the system is done as collective operational task — the way of working is defined by an existing goal of enhancing planning process by authoring packaged learning scenarios and giving space and tools to share it publicly to other teachers.
2. There exist two subsystems — meaning users and the software itself that intertwine in the usage process.
3. LePlanner system is open in a sense that it allows a degree of adaptation to the environment that is represented by its users' activities. The content of LePlanner is

created solely by its users and therefore is defined by them. The scenarios that users create and "fork" are not controlled in any way by anyone except for the acting user. Though the tool is targeted primarily at the teachers audience, its content can be consumed and functionality be accessed by anyone — the user pool is not limited and any person can register. Another thing about the LePlanner's audience is that even though it was designed by an Estonian developer and meant for Estonian users, the site is multilingual and it's user base could easily be expanded to be international.

4. LePlanner can be certainly said to be unfinished — the front page of the LePlanner site states that it's in beta currently, and a lot of design, development and testing cycles is planned for 2017 and later years.

LePlanner is designed in such a way that any user can read, create, augment a scenario. From the point of view that considers sociotechnical system to be an ecosystem of users providing learning services to each other (Pata & Bardone, 2014), LePlanner itself represents a constrained, meta-designed habitat for these services to grow and be utilized. The concept of knowledge building is also applicable here. Knowledge building ends up creating cognitive artifacts that externalize and focus the learnt information and afford easier learning for others (Tammets, Laanpere, & Pata, 2013; Scardamalia & Bereiter, 2003).

Teaching is an example of a loosely coupled work domain which is typical for humanities. Usually such domains are characterized by high degree of uncertainty (Andersen et al., 2001). LePlanner represents an attempt to design a tightly coupled system that would decrease uncertainty by lessening the degrees of freedom and enabling self managed aggregation and organization within the constraints set. In terms of the Skills-Rules-Knowledge theory introduced by Rasmussen (1983), it would also make work more based on rules or skills rather than on knowledge, meaning that activities become less dependent on internal mental operations and therefore performance would be enhanced.

Pata and Bardone (2014) utilize also the concept of enculturation. Enculturation (enrichment) is a process which may be described as reconstruction of environment by humans to adapt it to their goals. There are two types of enculturation; it can be emergent, that is arising in a self-organized ecosystem, and purposeful, where the system environment was predesigned.

Even if purposeful enculturation is more frequent when we consider HCI applications, in almost any predesigned ecosystem there is always a space for emergent enculturation, and it is imperative that any design should support it within chosen constraints. Hence LePlanner success depends on supporting not only purposeful but also emergent enculturation which is the product of student activities that in turn organize the learning services competition. Moreover, the activities of many learners help patterns to emerge during enculturation process that are shared among people. Each learning scenario represents a learning pattern in itself, and users adapting that pattern in various ways can be an interesting case for research. This way individual chance seeking becomes a social/cultural process and solidifies knowledge (Pata & Bardone, 2014).

Most practical applications in the field of HCI represent artificially constructed ecological niches around which users build their own cognitive niches. Invariants in LePlanner are represented by the interface cues, or functionalities (elements). Following the conceptual frameworks of Gibson and later researchers, we can say that users perceive its affordances through the process of separating various invariants in the interface via "attunement to relevant aspects of environment" (Bardone, 2011).

2.7. LePlanner as a technology enhanced learning ecosystem

We may consider LePlanner as an example of technology enhanced learning system mentioned by Vatrapu (2009). Indeed, it is clear that LePlanner serves as a learning helper tool for specific audience, helping to learn for instance new methods of teaching (Rõbtšenkov, 2016), even though some accidental terminological confusion might be caused by the fact that its users are not only learners but also teachers.

LePlanner represents also an ecosystem as mentioned earlier, with some specific features characterizing it as a learning oriented application. Following Pata and Bardone (2014) we can suggest that this ecosystem consists of learning services provided by different users. In it experts externalize their knowledge, and it gets appropriated by the system (Magnani & Bardone, 2008). Distributed cognitive networks "facilitate knowledge transformations" (Pata & Bardone, 2014), each scenario and each user in the system could be seen as offering own knowledge to others, fighting for attention, popularity, and, what is more important, for alignment with other users' goals. These services as a result of the struggle compete with each other (in popularity or number of favorites), form alliances (via the followership functionality that allows to connect users, and forking, which connects scenarios), perish (Pata & Bardone, 2014) in the process that might be called enculturation (see 2.6).

For each member LePlanner grows a cognitive niche of tools, concepts, actions as a result (Magnani & Bardone, 2008). It may correspond to the ecosystem metadesigned by the system creators to some, small or large, extent. Thus, looking into the affordances as perceived by the community members may show how well the ecosystem supports building such a niche.

3. Methods

The methodology of the study was elaborated in consultations with the study's supervisor, Kai Pata. Useful contributions and recommendations were provided also by the LePlanner creator, Romil Rõbtšenkov, and professor David Lamas. The active phase of research started in September 2016 and was finished by February 2017, though the idea of study on affordances was discussed earlier in summer of 2016. The main idea of the study is to evaluate affordances in perception of LePlanner users obtaining the user estimations on basis of sample tasks executed by them.

We decided not to go with naming of the affordances by users themselves this time. Gibson's theory posits that "arbitrary names by which they (affordances) are called do not count for perception" (Gibson, 1979). Therefore it does not matter how users call an affordance. Pols (2012), however, argues that a certain framework can be used for describing affordances by system designers (see 2.2.1.1). Anyhow, it is possible that the users participating in the research fail to recognize affordances as defined by the researchers or system designers as labelling them can be done in an unclear or misleading manner. However, this is the risk that is taken in this study; other option would be to obtain possible descriptions of affordances directly from users utilizing some mechanism for merging them. That is clearly a way in which future work could go (see 5.1).

3.1. Sample

The sample of the research is limited to a group of LePlanner users, with population being all of those who potentially could use it. As was mentioned before (see 2.5), LePlanner is targeted at teachers mainly, but there are no limitations for allowing any users to enter and use the system. It is a convenience sample in a sense that the sample was defined naturally by taking a group of teachers — all being students of the Tallinn University class Haridustehnoloogia ja õppimisteadused (TLU code IFI7209) taught by this study's supervisor.

There are 21 participants in the selected sample, with different backgrounds. The only common traits were that they all are students of one specific course and they are all Estonians. The participation was done as a in-class task, but participating wasn't strictly mandatory. It was allowed to save the entered data in an unfinished state and finish within a month.

3.2. Overview of experimental design

There are 7 stages to the study:

1. Inventory of the LePlanner functionalities (interface elements);
2. Defining the groups of affordances that the tasks will be based on;
3. Constructing the tasks description that would allow to obtain relevant answers;
4. Inferring the proper labels for possible affordances for all the tasks;
5. Building the research instrument (survey);
6. Obtaining the answers generated by the instrument;
7. Analyzing the results.

3.3. Phases of work

3.3.1. Functionalities inventory

First of all, the study needed clear account of all the interface elements that are present in LePlanner. A list of functions was done in the study by Rõbtšenkov (Rõbtšenkov, 2016, Appendix 3) that are related to various parts of the interface, and it provide some help when compiling the inventory.

Not all of the elements would be relevant for the research, but having them inventorized was deemed a good idea to be able to quickly choose from them later. Following the experience provided by the research done by Pata, Pedaste, and Sarapuu (2006), the screenshots of specific elements could be utilized as resources for creating maps and schemes with the aim of obtaining a good overview of the study's intermediary and final results. The task of finding appropriate working labels for different elements was relatively easy for the author as there was a long standing interest in naming the interface elements and his PhD defended in 2009 in Moscow State University dealt partly with the problem of labelling various custom interface elements as applied to content related websites.

It was decided to use separate application screens for grouping of specific elements. Obviously, same elements are often reused in the interface of LePlanner through several screens; for example, the search form is repeated almost on every screen of the application.

We can also mention subscreens which can be defined as dynamically revealed parts of a parent screen of specific graphic user interface (GUI) based application. These subscreens can be of various types and are labelled by UI designers in various ways: it could an overlay, a part of tabbed interface, a menu etc. In this study for convenience subscreens will be considered as separate screens because in LePlanner they mostly take up all the window space and thus it could be argued that it makes little difference for a user (given also that the transition from one page to another in LePlanner is relatively seemless since it is implemented as a Javascript-based app).

Throughout the LePlanner interface we can account for 11 screens that can be grouped by type of activity and navigation role:

1. Front page
2. Create scenario
3. Scenario — Text view
4. Scenario — Timeline view
5. Edit scenario — Details view (subscreen)
6. Edit scenario — Timeline view (subscreen)
7. Edit scenario - Timeline view — Resources (subscreen)
8. Edit scenario - Publish (subscreen)
9. Search results
10. User page

11. User list
12. User settings

The author filtered out the following screens that are not related to LePlanner specific activities or, like the last one, simply do not have enough elements to choose from:

1. Front page
2. User settings
3. Create scenario

These screens can still be used as a part of task (see for example the first task which starts from the front page), but they do not contain any interface elements that are of interest to our study. They have been included to allow participants to more easily situate themselves within specific circumstances — otherwise the task advancement could appear as unnatural.

- **common**
  - 1F.png, 3I user-scenario-widget-link.png
  - add-button.png
  - delete-button.png
  - details-mode-button.png
  - follow-button.png
  - most-commented.png
  - most-favorited-tab.png
  - most-viewed-tab.png
  - open-button.png
  - open-link.png
  - publish-mode-button.png
  - rearrange-button.png
  - save-continue.png
  - scenario-title-index-link.png
  - search.png
  - subjects-multiselect.png
  - timeline-mode-button.png
  - user-index-link.png
  - user-menu.png
- **elements on unused screens**
  - **Create scenario**
    - description-input_create-sc.png
    - title-input_create-sc.png
  - **Edit - Publish**
    - delete-scenario-button.png
    - lang-select.png
    - pubstate-select.png
  - **Front page**
    - subjects-list.png
- **Task 1 - Scenario - Text view**
  - 1P.png
  - 1Q.png
  - 1R.png
  - 1S.png
  - 1T.png
  - 1U.png
- **Task 1 - Scenario - Timeline view**
  - 1I.png
  - 1J.png
  - 1K.png
  - 1M.png
  - 1N.png
  - 1O.png
  - favorite-button.png
- **Task 1 - Search results**
  - 1C.png
  - 1E.png
  - 1G.png
  - language-multiselect.png
  - search-results-field.png
- **Task 2 - Edit - Timeline**
  - 2J student-resources-intarea.png
  - 2K teacher-resources-intarea.png
  - 2L.png
  - 2M.png
  - activity-duration-icon_edit-timeline.png
  - activity-studentnum-icon_edit-timeline.png
  - conveyors-list.png
  - resources-list.png
  - student-resources-button.png
  - teacher-resources-button.png
- **Task 2, 3 - Edit - Details**
  - 2A.png
  - 2B, 3L.png
  - 2C grade-input.png
  - 2D class-duration-input.png
  - 2F.png
  - 2G.png
  - 2H.png
  - 3J.png
  - 3K tags-input.png
  - activity-duration-input.png
  - activity-input.png
  - description_edit-details.png
  - inclass-check.png
  - outcomes-input.png
  - outcomes-select.png
  - students-num-select.png
  - title_edit-details.png
- **Task 2, 3 - Edit - Timeline - Resources**
  - 2N resources.png
  - 2O, 3O coauthorship-select.png
  - 2P conveyors.png
  - 2Q displays-checkboxes.png
  - activity-duration-icon_edit-timeline-resources.png
  - activity-studentnum-icon_edit-timeline-resources.png
  - conveyor-name-input.png
  - conveyor-url-input.png
  - delete-resource-button.png
  - location-url-input.png
  - resource-name-input.png
- **Task 3 - User page**
  - 1L, 3E follow-big-button.png
  - 3D.png
- **Task 3 - Users list**
  - 3A filter-users-input.png

Figure 3. The list of files representing elements' screenshots (sorted by screens). The files referred by element codes are selected for being included in the survey

After that both screenshots of whole screens (all of the screens present in LePlanner) and specific elements were done and organized hierarchically (see *figure 3*). Common elements that could be found on multiple screens were separated into a category of their own. Unused screens were filtered out and moved into a distinct group. A tool that was utilized for taking screenshots of separate elements was found — the Firefox browser which allows to take screenshots of HTML nodes without the surrounding elements; this helped to optimize the time consuming process.

Both English and Estonian versions of LePlanner were inventarized in parallel — the first needed for presenting in the master thesis and the latter for displaying to participants who were mostly Estonian and for whom it would be logical (which would influence the appropriateness of affordance estimations in the end) to use the correspondent version of the application.

As the experimental design is rather complex, some internal conventions for labelling were applied. The author coded each element with its own label. A label consists of the number of task and the letter (in alphabetical order) signifying the position of an element in the screens order of this task. Numbering is continuous through the same task. For example, the Follow button is coded as 1L because it represents a part of the first task and is preceded by elements A-K through the screens 1 and 2 of this task.

3.3.2. Defining the basic groups for tasks

As Pata notes, "any individual conceptualizes learning affordances personally, but the range of similar learning affordance conceptualizations may be clustered into more general affordance groups" (Pata, 2009). Following this, the author defined groups of affordances to construct test tasks further on. In accordance with the three groups of user activities (see 2.3), these groups of affordances can be indicated:

- scenario searching and filtering — **findability and appropriateness**;
- scenario creation and editing — **creatability and representability**;
- social activities — **reputability accumulation and awareness**.

3.3.2.1. Findability and appropriateness

As Pata and associates note (Pata et al., 2017), "appropriate scenarios must fit to teachers' pedagogical epistemologies as well as context in hand". This group contains the affordances related to activities that take place with a goal of finding a scenario fitting to particular teacher's need. For example, a user could want to use the application for finding a scenario adapted for kindergarten students, or a scenario on NATO politics in Europe, and so on.

This is somewhat basic group that can be considered to be actualized much more frequently then the other groups. This is in particular because such activity requires no registration in the system, which serves a natural tier for many user activities. There is a wealth of context factors that influence certain selection of affordances for each user, and almost all of them are very specific to either user in general or current situation: educational level, spectre of competences, learning outcomes that a user pursues. LePlanner is designed in such a way that user may rely on the automated system of recommendations or proactively track what he needs utilizing the app navigation — search, tags, subjects, and topics taxonomies, listings sorted by various criteria (top commented, for example) and so on.

3.3.2.2. Creatability and representability

Creatability relates to ability of users to initiate and efficiently design new learning scenarios, while representability — to the system-afforded options for presenting your scenario to other users of the application in a better way. "Creatability depends on how well the learning design specifications can represent the pedagogical language of users, their needs to the learning scenarios and its activities", and representability is about conformance to users expectations in how a scenario should present itself for the optimal appropriateness (Pata et al., 2017). The fact that learning application is an ecological system is much more important for this group of affordances than for the previous one, because here the relations between users actively begin to emerge. For example, a user designing a learning scenario would pay more attention to how well it represents his skills and inventory of tools and therefore how strong would be the influence and popularity of his product.

The goals related to this group can be supported by a flexible variety of ways to enrich the included digital resources inventory in a scenario, present a scenario visually in different modes for optimal readability, and so on.

3.3.2.3. Reputability accumulation and awareness

For this group of affordances community validation is an important enabling factor. The properties of an ecosystem as a constantly changing niche of competing users and resources also emerge here in a most vivid way. Reputability accumulation refers to a valued resource for any community — reputation. Even though in LePlanner it is not manifested formally in a highly noticeable fashion like in other sociotechnical systems such as Youtube or Facebook — there is little accessible metrics in LePlanner that allows to easily measure how reputable a user is — it is still present and is of value. (As one of such metrics the number of followers could serve, though.) Internal reputation can be connected to professional reputation, as indicated by Wasko and Faraj (2005).

Creating awareness is another affordance that is connected to valued resource — popularity. It points to two sides at the same time, referring to awareness **of oneself** of the latest updates in the system, and also to awareness **for oneself**, which is built to enhance popularity.

For the affordances themselves refer below (see 3.3.4).

3.3.3. Planning test tasks

Based on the three groups of affordances mentioned above we constructed three test tasks for users. The aim of these tasks is to situate user into specific activities that are related to the chosen affordances before asking to answer the questions.

Each task was accompanied with 2 questions. The first question was represented by a Likert scale. The second question had a set of checkboxes accompanied by screenshots. For each task 2-3 interface screens were displayed with the exception of the third task which represents two tasks combined and therefore is larger (5 screens). In the survey the screens for each task were merged into one image for easier upload and control. The description of the tasks and questions is given below.

3.3.3.1. Task 1

In this task you need to find an appropriate scenario in LePlanner. Start from the start page and try to find a scenario that is interesting for you in some way. After finishing with that return to this page.

First task aims at submerging participant into the situation of searching for a specific scenario. It is indicated that the scenario should be of interest to this user. The author considered this approach more efficient for embedding participants into specific situation as compared to simply asking to locate predefined scenario. Looking for a resource valued personally may actualize affordances more prominently and that is the goal that was pursued.

3.3.3.2. Task 2

In this task you need to create a new scenario in LePlanner. After finishing with that return to this page.

This task asks participant to create a sample scenario in LePlanner. It is assumed that being a teaching professional participant would create a scenario interesting to him personally and thus will be fuller situated in the task.

3.3.3.3. Task 3

In this task you need to: 1. get updates on what's happening in LePlanner; 2. make sure you're distinguishable there.

The final task has collected affordances related to actualizing intentions of 1) keeping oneself up-to-date and 2) gathering popularity as its goal. At early stages of planning it was thought to be 2 separate tasks, however due to smaller volume they were merged into one.

It can be that the second part of the task description should be clearer because currently it may not be understood correctly by all users.

3.3.4. Conceptualization of affordances

According to Heft (2003), "affordance meaning is also typically established by a feature's relation to a broader environmental context". The conceptualizations (labels) of affordances to choose from were taken in such a way so that they would be in agreement with the current task description.

Conceptualizations were defined in a brainstorm session according to approximate vision of how an expert user would perceive them (participants of the session could be considered as the expert users). Each affordance begins from a verb to highlight its relation to certain activities to the participants. In total there were 31 affordances for all the three tasks.

Task 1:

1. (1.1) evaluating appropriateness of scenarios for one's goal;
2. (1.2) evaluating the interactivity level of scenarios;
3. (1.3) evaluating the teacher/student engagement balance;
4. (1.4) evaluating popularity of scenarios;
5. (1.5) estimating the need for technology and resources in scenario;
6. (1.6) estimating duration of scenario;
7. (1.7) findability of scenarios by keyword;
8. (1.8) findability of scenarios by subject;
9. (1.9) findability of scenarios by popularity;
10. (1.10) findability of scenarios by user.

Task 2:

1. (2.1) raising the level of findability of own scenario;
2. (2.2) raising the level of appropriateness of own scenario;
3. (2.3) raising the interactivity level of own scenario;
4. (2.4) establishing the teacher/student engagement balance;
5. (2.5) adding popularity to scenario;
6. (2.6) using existing scenarios to make my own;
7. (2.7) adding actions to scenario;
8. (2.8) adding resources in scenario;
9. (2.9) adding duration of scenario;
10. (2.10) adding learning outcomes to scenario;
11. (2.11) adding digital technologies to scenario.

Task 3:

1. (3.1) filtering scenarios by recency;
2. (3.2) filtering scenarios by selected users;
3. (3.3) filtering scenarios by popularity;
4. (3.4) increasing findability of your scenarios by popularity;
5. (3.5) increasing findability of your scenarios by user;
6. (3.6) increasing findability of your profile to show off other scenarios you have created;
7. (3.7) showing your scenario among popular ones;
8. (3.8) creating popularity for scenarios;
9. (3.9) creating popularity for users;
10. (3.10) increasing the number of users following you.

The affordances were chosen to cover as many activities within LePlanner as possible, except for those that are not related to LePlanner-specific user goals and refer more to basic system features (such as managing your user profile details like name, email, and so on).

3.3.4.1. Grouping affordances by co-authorship level

Following Väljataga, Laanpere, and Fiedler (2015), the author decided to group the affordances based on their classification of the **levels of co-authorship** (LoCA). Using grouping would allow to see more easily how different kinds of activities emerge in LePlanner. The levels seem to perfectly describe different degrees of interactive activities in a practice-oriented fashion. As opposed to traditional notion of interaction, these levels cope more directly with how students digest and (re)process the existing resources provided by teacher or other students.

The levels of co-authorship suggested by Väljataga and associates (2015) are summed up in seven groups, namely (in order of increasing degree of interactivity):

1. **Consume** — read, view, listen;
2. **Annotate** — mark, comment, tag;
3. **Manipulate** — drag & drop, fill;
4. **Interact** — submit (enter responses);
5. **Expand** — add content without changing significant parts of the source content, aggregate;
6. **Remix** — edit content;
7. **Create —** create new content from scratch.

The author decided to appropriate this useful framework while regrouping the levels of co-authorship into four new groups for the usage in the survey on the basis of what LePlanner specifically may afford (conceptualized beforehand, see 3.3.4). Note that some group labels changed their meaning compared to what the framework of Väljataga and associates (2015) offers.

1. **Consume**. Basic level without any higher level interactive activities, suggesting reading, viewing, listening;
2. **React**. This group is represented by functionalities associated with reacting upon own content and promoting it;

3. **Expand/Remix**. It was decided to merge these two groups as presented in the LoCA framework of Väljataga and colleagues (2015) as LePlanner because it was found out that only one affordance would correspond to it, namely "using existing scenarios to make my own". Both expand and remix levels still refer to the same affordance though, because it can be used for expanding as well as for remixing depending on user goal;
4. **Create**. The most advanced level where content is being created without any utilization of or reference to existing content.

One additional group was included — **interact**. This would comprise interacting with others' scenarios without reappropriating them. However, the only corresponding affordance (comment a scenario) was finally left out from the survey, therefore the group was ultimately excluded.

The affordances were distributed in these groups in this manner:

Consume:

1. evaluating appropriateness of scenarios for one's goal (number in the task group 1.1);
2. evaluating the interactivity level of scenarios (1.2);
3. evaluating the teacher/student engagement balance (1.3);
4. evaluating popularity of scenarios (1.4);
5. estimating the need for technology and resources in scenario (1.5);
6. estimating duration of scenario (1.6);
7. findability of scenarios by keyword (1.7);
8. findability of scenarios by subject (1.8);
9. findability of scenarios by popularity (1.9);
10. findability of scenarios by user (1.10);
11. filtering scenarios by recency (3.1);
12. filtering scenarios by selected users (3.2);
13. filtering scenarios by popularity (3.3).

Create:

1. raising the level of appropriateness of own scenario (2.2);
2. raising the interactivity level of own scenario (2.3);
3. establishing the teacher/student engagement balance (2.4);
4. adding actions to scenario (2.7);
5. adding resources in scenario (2.8);
6. adding duration of scenario (2.9);
7. adding learning outcomes to scenario (2.10);
8. adding digital technologies to scenario (2.11).

React:

1. raising the level of findability of own scenario (2.1);
2. adding popularity to scenario (2.5);
3. increasing findability of your scenarios by popularity (3.4);
4. increasing findability of your scenarios by user (3.5);
5. increasing findability of your profile to show off other scenarios you have created (3.6);
6. showing your scenario among popular ones (3.7);
7. creating popularity for scenarios (3.8);
8. creating popularity for users (3.9);
9. increasing the number of users following you (3.10).

Expand/Remix:

1. using existing scenarios to make my own (2.6).

Interact:

1. comment the scenario (was removed from the actual survey).

3.3.5. Instrument

The survey was implemented using LimeSurvey which is a flexible software solution for creating research oriented surveys available to students of Tallinn University (other survey software was also considered and tried out). Conducting the survey online seemed to be the best option because it was suggested to be done during class time and in a computer room where all the students have access to web browser.

3.3.5.1. Survey structure

The survey consists of three main parts — the introductory questions section, the tasks section, and the final questions. Overall there are 9 questions in the survey — 2 introductory questions, 6 (3x2) in the tasks section, and the closing question was only one. The survey length was planned in such a manner so that it would not take more time than one class, it could be conducted as a part of a class and there would not be need to hold up the participants.

3.3.5.1.1. Introductory questions

The survey asks participant to fill his or her name and the surname in the beginning (these are mandatory fields). This is done in order to allow associating the affordances of each specific participant with him or her and possible tracking using the real data on LePlanner usage. There was no need for keeping the attribution private as all of the participants are officially enrolled in the Haridustehnoloogia ja õppimisteadused course. This data has not been used in the current study but could be utilized in future versions of the study.

3.3.5.1.2. Affordance strength evaluation question

This question aims at defining the overall comparable strength of the affordances that may be actualized in the current task. The word "affordance" was not used in the description of this question to prevent misunderstanding of the term which should be largely unknown to wider public outside of design or science professional fields. The less specific wording "support for a goal" was used instead. The author considers this decision suitable because goal (and intention) is an inseparable component of actor-environment system where affordances are actualized. It was deemed also easier for a participant to assess the level of alignment of LePlanner as a tool with his/her goals.

The Likert scale was used to allow participants to define the degree of actualizing of affordances in general for each task. The author chose simpler 5-point scale instead of 7-point which is recommended by some researchers (Finstad, 2010) to reduce the complexity of choice (Krosnick & Presser, 2010). The author also decided to remove the intermediate labelling from the Likert scale and keep the 1 point ("Not at all") and 5 point ("Fully ") labels. To ensure that the scale is understood right these labels were in rearticulated, more clear (verb-oriented) form put in the caption of the question ("Please evaluate to what extent LePlanner supported each goal in this task on a scale from "Doesn't support at all" (1) to "Supports completely" (5)."). It was also possible to leave no answer for an affordance.

3.3.5.1.3. Associating affordances question

The association question was designed to be the most important part of the study. In this part participants were asked to relate affordances predefined for this task with the interface elements depicted in series of screenshots. Again the evaluation was meant to be highly situated in the task circumstances, such as finding a scenario or creating a new one.

The choice of the right format for the question proved to be difficult, due to complex structure. Some options to make the survey experience interactive were considered. It was decided ultimately that the simplest way technically and in terms of ease of understanding for participants would be to allow associating with screenshots where elements would be highlighted in some way. The screenshots were done with the Firefox browser. Some interface elements were removed from pages prior to taking screenshots with help of browser's Developer tools, in order to make the screenshots fit comfortably on a survey page. This was done in as non intrusive way as possible, so that all the permanent elements of interface would stay where they are and the screenshot would be perceived by participant as staying intact. As a rule, only the elements which were repeated several times were deleted, for example, out of three comments one was kept and the others removed. The resulting screenshots can be seen in the Appendix 1.

As the numbering of elements is sequential and continues through all the screenshots, they were merged into one image per each task. It was decided to highlight the necessary elements instead of some free discovery based testing — fixating the elements allows to simplify the process of search for participants and to avoid labelling or position ambiguities for the researchers. The author made sure that even though some elements reappear across many or all screenshots, no element gets highlighted twice. Elements were highlighted by red frames in the Evernote Skitch tool, with a letter placed nearby. The rationale for selecting the highlighting color was that red color is almost absent from the LePlanner standard palette and therefore would contrast well with the screenshot itself while leaving the latter readable. Screenshots were published on the TLU private FTP space and linked with the survey. It was also possible to open a screenshot in a new window as a separate image, which could be useful due to the limited width of the LimeSurvey survey layout. This option was communicated by a tooltip. The design of the question can be seen in Appendix 2.

Design of this question in the survey remains a thing to improve in future. Again due to the limited page width, it was quite hard to discover an optimal format for it that would fit well on screen and would not pose some usability or understanding problems for participants. In the end the question type of Array (numbers) was chosen for this subtask because it seemed optimal at least in terms of compactness criteria.

3.3.5.1.4. Closing question

The closing question which was an open text field pursued a goal of collecting the survey feedback from participants. As we can see it proved useful and some feedback was gathered even though filling this field was not mandatory.

3.3.6. Running the survey

Though the survey was meant to be run during a class, it was open for filling in by the students. Initially it was planned to open the survey for a week but after the first results it was decided to leave the survey open for a longer period. Overall the survey was accessible to participants for a month, after which it was set as expired. A link to the survey was distributed among the students by the teacher of the Haridustehnoloogia ja õppimisteadused course. The survey was prepared and published on the Tallinn University's LimeSurvey public server (minitorn.cs.tlu.ee), where it was easily accessible anytime from any computer or mobile device until it expired.

The survey was conducted after the students already had one class session devoted to LePlanner and at least one scenario developed with it as planned by the course. Therefore they had been relatively familiar with LePlanner. It is important to note that prior to participating in survey students had to explore the system themselves with help of a tutorial video, but without teacher control or intervention (Pata et al., 2017). So there were no imposed rules to follow or supervisor pressure — users were free to construct their own cognitive niches around LePlanner based primarily on interaction with its interface.

3.3.7. Data analysis

After the end of the survey the data was analyzed using descriptive statistics. A CSV file was taken from LimeSurvey server and cleaned up from empty answers. Then the data for the first question was used for calculating averages per each affordance (using Microsoft Excel).

Empty values in calculations were not included, and value 1 was considered as absence of any affordance actualization.

The data gathered from the second question was analyzed by calculating frequencies of affordances per each interface element. The absolute numbers were converted into percentages, sorted, and based on that a 2D (top down) surface plot was built.

3.4. Conclusion

The research methodology was designed in such a way so that general strength of each affordance would be shown for each contextualized set of goals. Emerging connection between specific affordance and interface element would be elicited as well. The next chapter discusses the actual data obtained in the course of the survey.

4. Results and discussion

Overall there were 16 students who in some way have participated in the survey out of 21 enlisted to the Haridustehnoloogia ja õppimisteadused course. One student has entered some data twice and 3 students have not entered any data after providing own names. More or less full data was provided by 14 participants. Still, some empty fields were submitted (they were ignored when doing the statistical calculations).

The survey was open for participation from 23 October to 27 November 2016. There was no specific timeframe for it, but the last answer was submitted on 6 November (with the first answers registered on the date of publishing the survey) and therefore it can be said that the active period of the survey took approximately 2 weeks.

4.1.1. Evaluation of affordances strength

Users evaluated how well LePlanner exhibited various affordances in general in 3 context-dependent tasks. As the result, all of the affordances suggested to users were evaluated as having actualized to some extent (it was also an option that an affordance could be revealed as totally unactualized, meaning that all the users would select "Not at all" option). Here is the summary chart illustrating the affordances actualization strength over all the 3 test tasks of the survey, grouped by co-authorship levels that were ideated prior to evaluation. Note that those mostly overlap with tasks, with some exceptions.

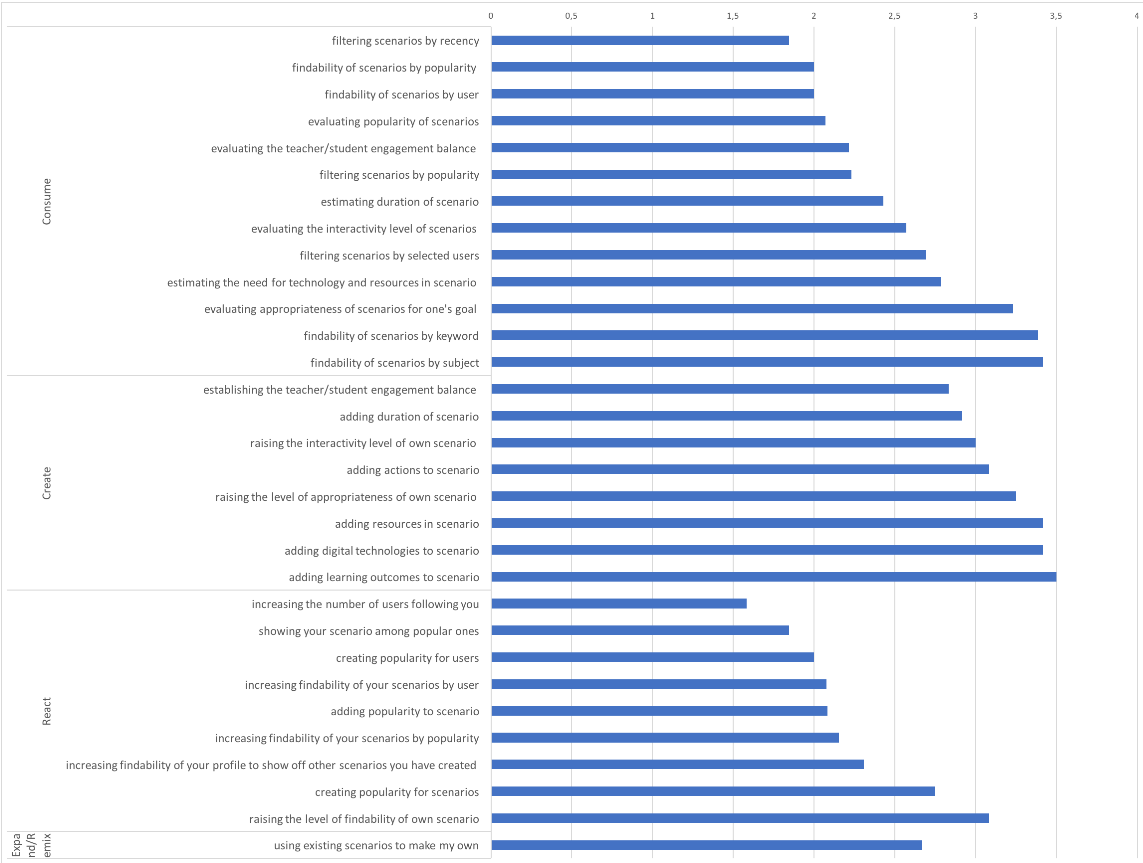

Figure 4. *Comparison of affordances evaluation by co-authorship levels*

Figure 4 indicates that among the leading affordances that were actualized strongly for the participants per each level of co-authorship were **findability of scenarios by subject** (consume), **adding learning outcomes to scenario** (create), and **raising the level of findability of own scenario** (react), with the first one being the winner. The top affordances LePlanner supports were, apart from the listed above, **findability of scenarios by subject**, **adding digital technologies** and **resources** to scenario, **findability of scenarios by keyword** (*Figure 5*).

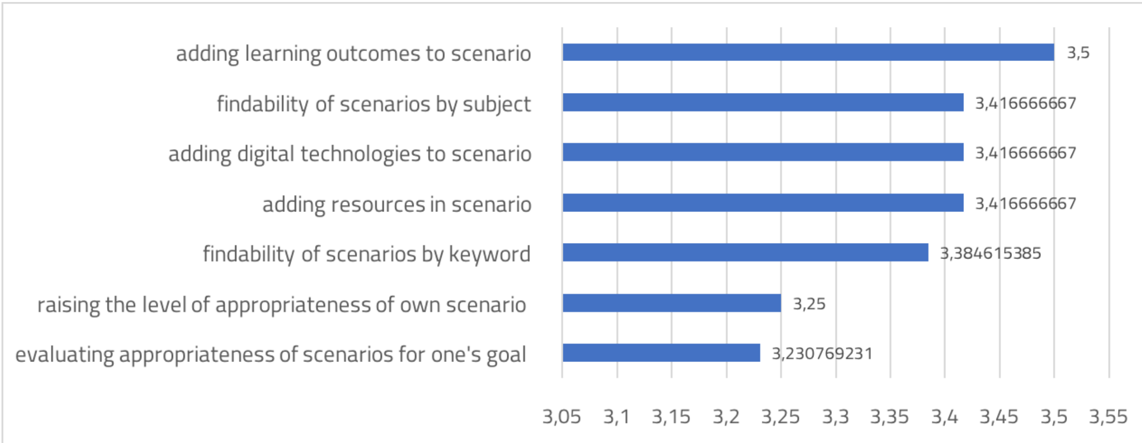

Figure 5. *Top affordances by strength in LePlanner*

Some interesting observations can be made if we look at each level separately as well. There is a significant gap between the top three affordances and the rest of them for the Consume level — it is 0.45 points of the scale, or approximately 7% from the maximum value. Users of LePlanner thought that, in context of pure consumption of content, it affords some findability related activities much better than the other ones. This concerns findability by keyword (afforded by search) or subject (afforded by the subjects select field), both of them can be found on the search page. This may be due to the developed system of filtering and searching for content in LePlanner, there is a lot of options in its design for a user who looks for something specific.

Findability by popularity or by user, on the contrary, scored especially low. This may be related to the label inconsistence with the interface provided semantics of the system — the term "popularity" (*populaarsus* in Estonian) may not have associated mentally at that moment for participants with the existing options for filtering by number of favorites or views.

High result of the evaluating appropriateness for a goal affordance also may reveal that the participants deemed finding a scenario in a certain way to be easy and fast in general. In spite of some problems with searching for most popular scenarios, the top three affordances might show that generally the interface supports the user goals for such particular context as direct search of specific scenario. At the same time, users consider filtering scenarios by recency to be the most poorly supported in LePlanner which is quite difficult to explain.

On the Create level there is no clear winner as well. The top three affordances here also go ahead of the rest, though this time the gap is much smaller. They reveal that it is clear to users how to add either learning outcomes (which stand out on the screen and are hard not to notice) or digital technologies and resources. The latter is indeed a surprise because one needs to explore the interactive scheme to discover them on the second screen of the scenario edit page (Edit scenario — Timeline), and this might be considered more difficult to find. Adding duration affordance got few points which can be intriguing because the interface element affording it is again can be seen on the first screen of the Edit scenario page.

The third group level, React, has the most variation in affordances strength — the strongest affordance, raising the level of findability, is almost twice as strong as the weakest, increasing the number of followers. The latter, with 1.58 points, is also the least actualized affordance in LePlanner, which may be of concern for designing a fully functional sociotechnical system — roughly half of users does not see an easy option to gain popularity in such a way. One more affordance lagging behind (it scores a bit higher than the previous one but still lower than any other affordance) is showing your scenario among popular ones.

Overall, from all levels of co-authorship the highest average affordance score pertains to the second level affordances (Create) — nearly 4% per affordance versus 3.13% and 2.73% for Consume and React accordingly. This might show that users of LePlanner are actually more interested in staying at this level — namely, creating their own scenarios instead of reading or settling down in the social ecosystem. It could indicate that the features related to those levels can be considered secondary and do not require major focus. Especially this concerns the React level — users neither see strong action possibilities for increasing their social status in the system nor probably desire to have them.

Some clustering (though not expressed in a very strong manner) that happens especially for top affordances may point at emergence of affordance networks as shown by Barab and

Roth (2006). One affordance could in such a case actualize another (Bardone, 2011), revealing to user a chain of possibilities in time or space (and indeed, some of the clustered affordances are proximal to each other in the interface).

4.1.2. Associating affordances with interface elements

According to Pata and associates (2017), the research done as part of this study identified certain "affordance landscapes", where affordances are distributed unevenly and have different strength across interface. An attempt was done to visualize these landscapes in a pronounced form as a two-dimensional surface plot (chart), a merged one and for each task separately. We also visualized elements grouped by levels of co-authorship which affordances they were associated with most, as a concept map (see *figure 6*).

Overall, quite diverse picture emerged. It can be seen that while some elements have a lot of affordances assigned by participants, other do not get any attention at all, which means that no affordances are perceived thanks to them. The latter elements are spread through tasks, but predominantly they belong to the tasks 1 (*find an appropriate scenario*) and 3 (*get updates* and *make sure you're distinguishable*). For example, widget with other scenarios (M1) almost lacks any affordances. On the other hand, some elements have their affordances quite blurred in user perception, such as big follow button (L1) or teacher resources icons (I1).

It can be seen that more uniform distribution of affordance strength was shown for the affordances belonging to create level (see Appendix 3). This demonstrates that affordances associated with creating scenarios were not only more noticeable, they were more dissolved in the interface, participants met the more often. This could lead us to concluding that 1) LePlanner supports creating scenarios better and 2) there are potentially more ways people could get these sort of goals done. At the same time, consuming content is supported strongly by only isolated number of elements, and poorly in general. There are less ways to consume in LePlanner even though some of them are really well articulated.

A more detailed analysis of the data provided by this question follows.

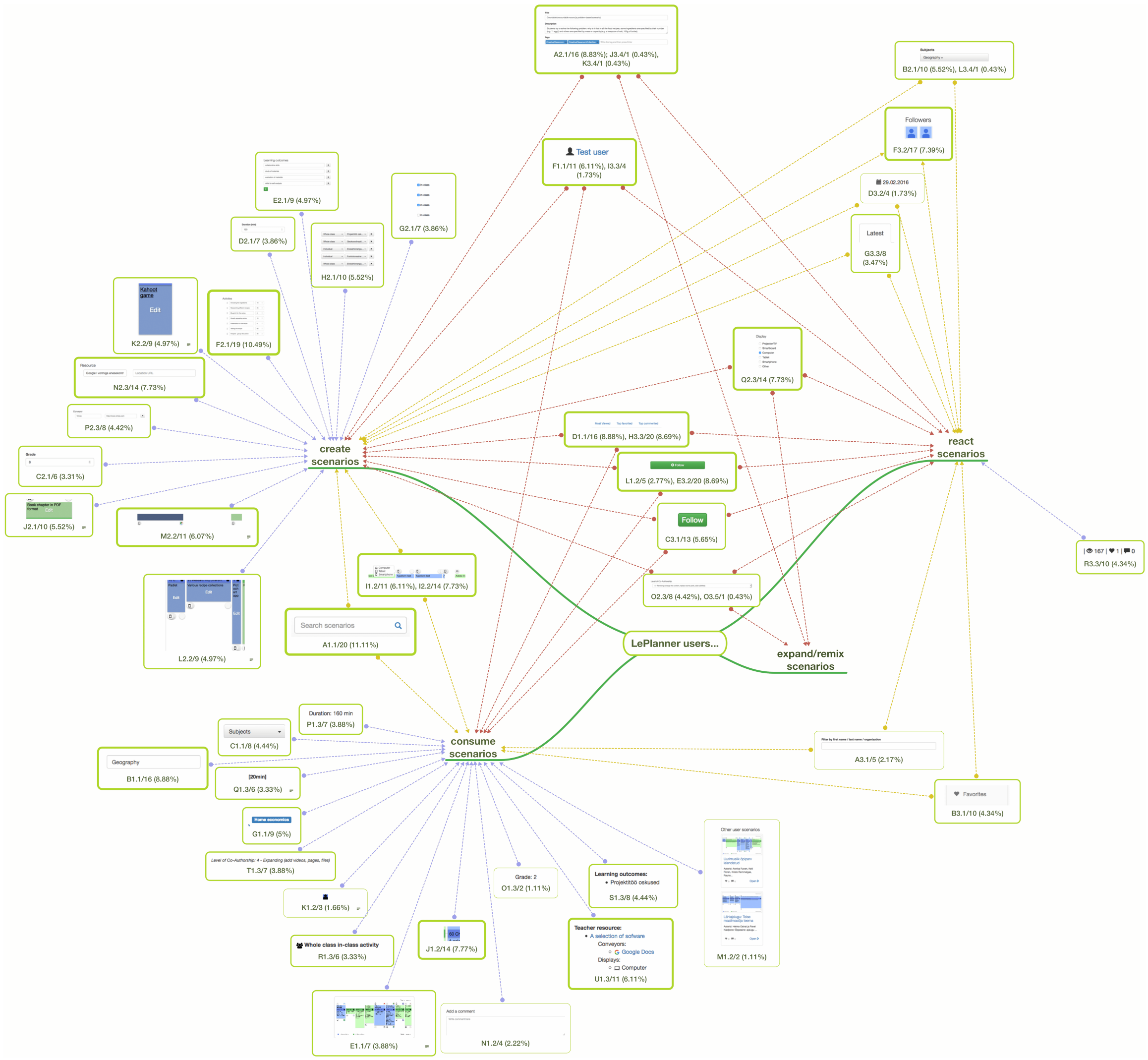

Figure 6. Concept map with LePlanner interface elements based on association frequency. Red arrow — element is related to some affordance on three levels of co-authorship, orange — two, purple — one. Border width indicates the overall association frequency for this element

4.1.2.1. Task 1

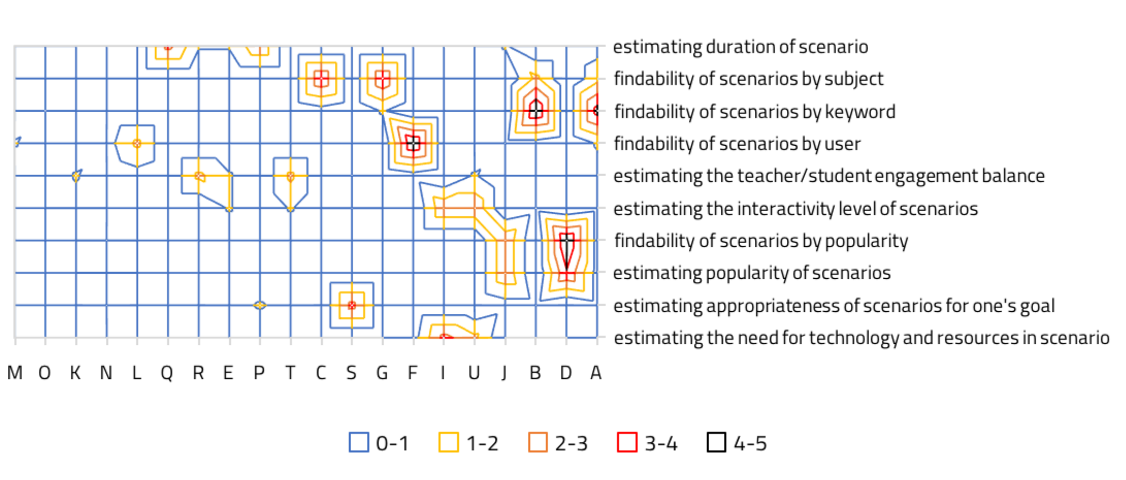

Figure 7. Elements associated with affordances for the 1 task

As can be seen on *figure 7*, there was quite a number of highly frequent affordances for specific interface elements for LePlanner screens from the task 1.

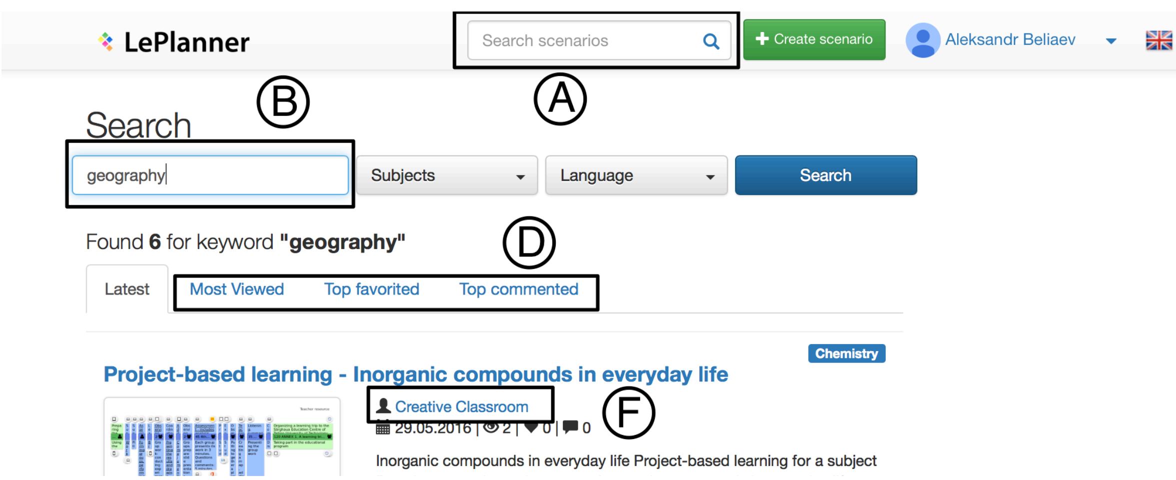

Figure 8. Elements with highest affordance strength for the 1 task

The most frequent were (see the *figure 8*):

1. search input in two design instances — A and B. Both were associated quite obviously with the findability by keyword affordance;

2. tab list for most favorited, most viewed, most commented links — D. It got related with the findability of scenarios by popularity affordance. What is a bit unexpected is that this affordance got a low score in the previous question, which might be explained by the appearance of a screenshot where this element is highlighted and is thus easier to associate;
3. user profile link — F. This element was considered supporting the findability by user affordance. Again, this affordance was not generally said to be supported by LePlanner in answers for the previous question, however, many users have indicated that it is supported on this screen, by this element. It may be hypothesised that some affordances (or their conceptualizations) are less generalizable and could be perceived in a clear way only in certain circumstances.

4.1.2.2. Task 2

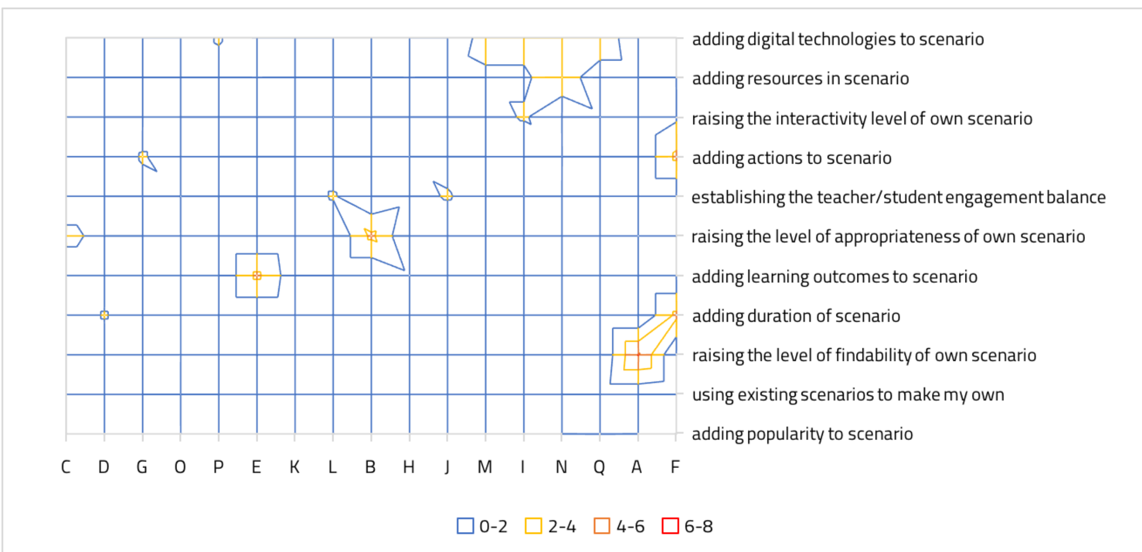

Figure 9. Elements associated with affordances for the 2 task

For the second, scenario creation task few affordances were assigned by participants (*figure 9*). The most popular were (*figure 10*) the scenario activity name fields (F) and the set of fields dedicated to basic description of scenario.

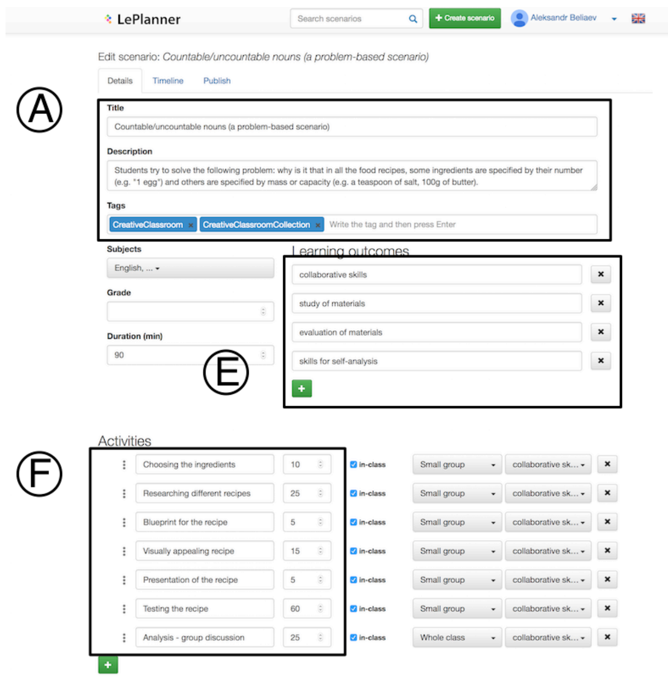

Figure 10. *Elements with highest affordance strength for the 2 task*

The subject select field was marked to some degree as raising the level of appropriateness, but two nearby standing descriptional elements — class level (C) and class duration (D) fields have received little attention. This may indicate that teachers value and know about the possibilities of Web for promoting content semantically, but care less about people who have already reached the scenario and need some necessary information about it. Many smaller elements were assigned to some affordances only sporadically here.

4.1.2.3. Task 3

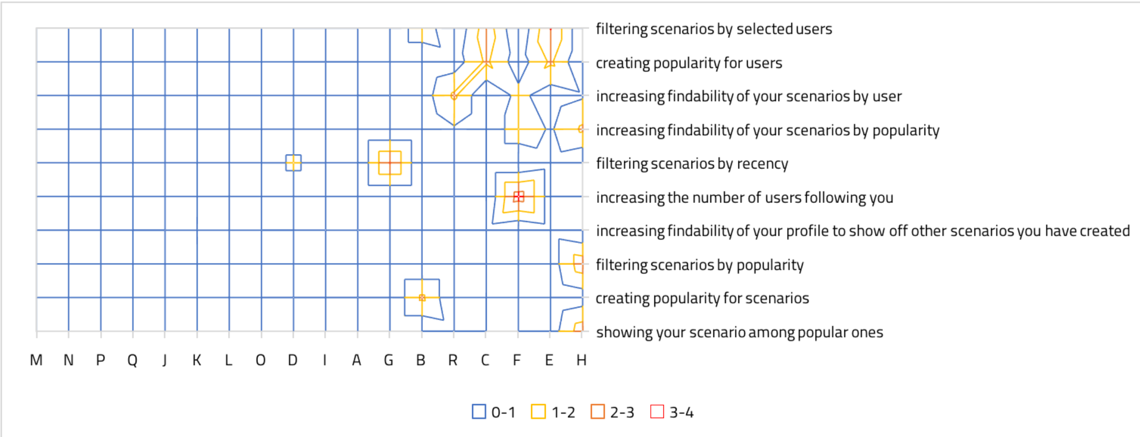

Figure 11. Elements associated with affordances for the 3 task

The third task, related to social activities, is the only one where some elements have not received any attention at all (*figure 11*). These are (*figure 12*) class level field (M3), class duration (N3), conveyor field (P3), and digital technologies/devices checkboxes (Q3). It shows that many of them were not perceived directly as corresponding to the current task and goal of becoming updated and distinguishable, but more probably were felt as simply editing options. Finally, it is possible that participants were tired by the end of the survey and paid to some options less attention.

One obvious choice of an element for being updated — tab item "New" (G3) — invoked only insignificant association, maybe because it is a kind of "blocked" affordance pointing at inability of action: it's impossible to click on this element as it is the already selected item of the tab list. Interestingly, another non interactive element, scenario popularity indicators group (R3), had higher strength then this potentially interactive, but clearly inhibited item.

Others are distributed through all the screens making part of the task. The list of followers (F3) has been attributed with some affordances related to users and popularity, and the tab list with filtering links (H3) gathered affordances both associated with consuming as well as reacting.

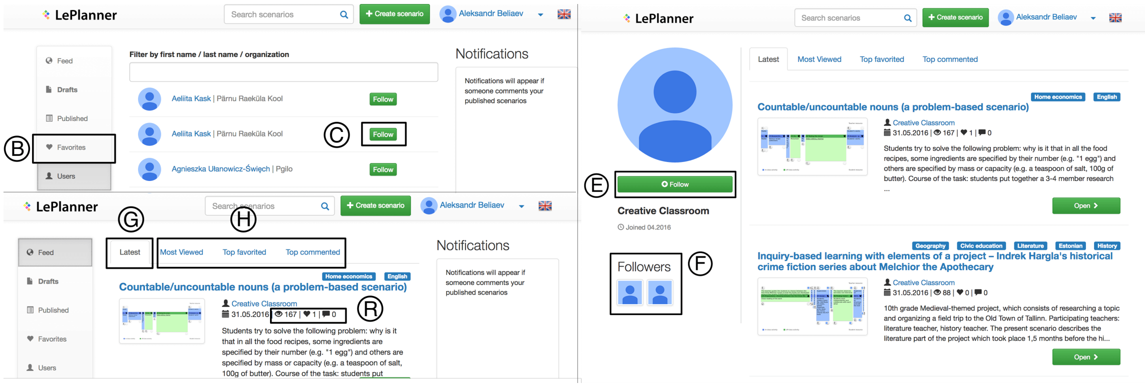

Figure 12. *Elements with highest affordance strength for the 3 task*

It can be discovered via the merged surface plot (Appendix 3) that the most inconsistent estimations were done for the elements in the first task, among them — tab list with filtering links (D), icons of teacher resources (I), follow user button (L). These were assigned the highest number of different affordances, for example, D got five different affordances attached, I — four, L — three and so on. Probably this variation is partly related to the fact that the first two elements were actually a group of inner elements, and that might have affected what users perceived. **An important lesson here is to avoid ambiguity** and refrain from highlighting several elements as one when conducting this type of research. However, it is not completely clear why the follow button also had several affordances assigned — related to users mainly. It is the brightest and the biggest interactive element on the page that maintains conventional visual look. It can be suggested that **inviting, vibrant, conventional design actualizes more affordances**, but also can be less specific then something more boring or experimental.

Overall, consume and create level affordances were assigned to elements (roughly) equally often, and react level affordances were less noticeable — participants preferred them less (see *figure 13*).

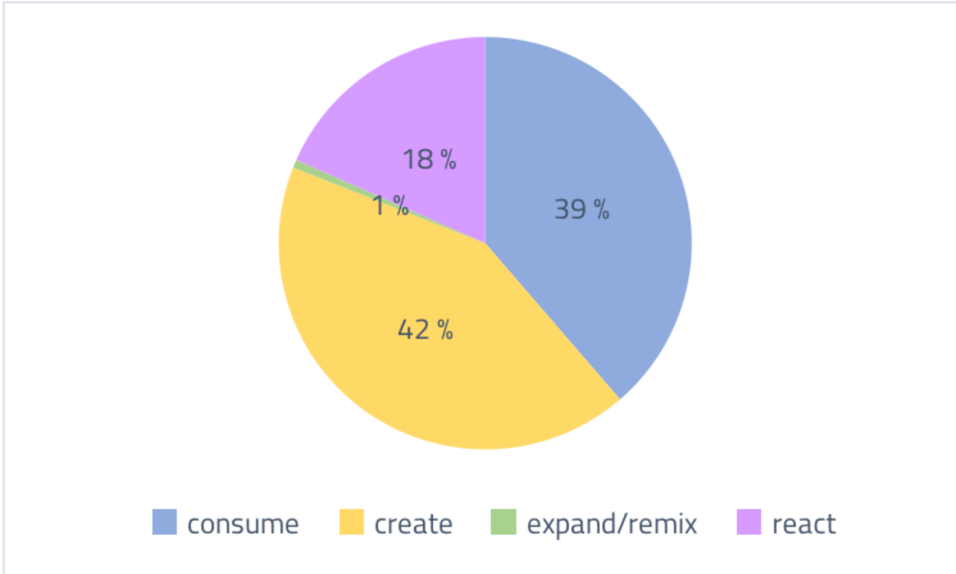

Figure 13. Affordance groups compared by total frequencies

Interestingly some screens were systematically less considered as having elements supporting an affordance. These are **Scenario — Timeline view**, **Scenario — Text view** in the first task, **Edit scenario — Timeline view** and its subscreen **Resources** in the second, as well as **Edit scenario — Details view** in the third.

4.2. Feedback and limitations

The participants left some useful feedback in the end of the survey, where an open text field was given for this purpose. Notably, users complained about the numerous checkboxes and elements that were hard to identify due to layout and because they were so numerous. Other people lamented on the usage of the term affordances (*lubavused* in Estonian) which was hard for them to understand and therefore to act upon. There were also complaints about the quality of the screenshots provided; apparently the possibility to open the bigger version of image was not clear enough, and some other solution is needed.

The feedback proved to be very useful for this study and future work will account for these and other problems.

5. Conclusions

To reiterate the research question of the study, the author attempted to find out how the affordances are distributed in LePlanner contextually across various interface elements, as perceived by users of LePlanner. This question has been answered with the survey based study done as a part of the thesis. The theoretical foundation has been provided by the literature review in the fields of human-computer interaction, ecological psychology, distributed cognition, sociotechnical systems theory, learning design. It was hypothesised that studying affordances perceived by users can aid design of a digital learning tool.

Plenty of interesting results emerged. It was found out that LePlanner in evaluation by its users highly supports tasks related to scenario creation. The data showed that affordances related to social aspects of the system were not strongly actualized in LePlanner interface for the participants. This could indicate that more attention is needed in the design of the social functions of LePlanner, it seems they should be more obvious and their presence in the system should be more grounded and tied to the learning design goals. Affordances of promoting your scenario (react group) caused the most disagreements among participants, which may point further at the need for design improvements on this level. It might be proposed that the react affordances should be designed for in a more prominent and clear way, otherwise this part of LePlanner functionality may pass mostly unnoticed by the users.

Users considered affordances related to findability of content to be supported by the application to a particularly higher degree then others. This was probably due to the developed system of filtering and searching for content in LePlanner. It was also suggested that inviting, vibrant, conventional design actualizes more affordances, but also can be less specific than it is needed causing misunderstanding.

Certain patterns were discovered in the study of affordances associated with specific interface elements. Users were most secure about affordances of those elements that were compound in nature (consisted of set of other elements), however, these elements also had most diversity in what affordance they were linked to. Thus avoiding ambiguity may be important. The study also highlighted the strength of affordances referring to promoting scenarios with help of metainformation as opposed to actually providing the scenario details that could be interesting to other users. Therefore it might not be useful to encourage users of LePlanner to think of making their scenarios popular within the community; rather, they might be more interested in making them findable in the Internet via metainformation they provided.

Some symptoms of emerging affordances networks, where affordances get actualized continuously in space or time, were also found, though more research is needed to see those in a clearer way.

Thus as a sociotechnical system in perception of users LePlanner currently is a bit imbalanced. Its functions related to creation and consuming learning scenario content might outweigh its social component as perceived through design. This social component is probably not so important for users and needs to be reconsidered. In a more general sense, it can be suggested that users do perceive LePlanner as a socially enabled ecosystem, but do not fully embrace their role in it. With more users and more social activities going on this might change, though.

In general it was revealed that exploring affordances perceived by users of a digital learning tool with even relatively small sample can provide some interesting insights which may aid making design decisions. The survey also got substantial amount of feedback from participants, which can help preventing the problems mentioned by users in future.

5.1. Future work

There is plenty of things that could be done to reaffirm the research results obtained in this study. Partly some data for this was gathered already during the study period, but it was invalidated by circumstances or deemed incomplete to be included given the timeframe for the master study.

1. The relatively small sample taken in this study may have affected the accuracy of data, and therefore it is viable to try to widen it with a larger number of participants. It

might be desirable to bring the study of LePlanner affordances from the university room “into the wild” by looking at how people using LePlanner on constant professional basis discover them.

2. An interesting option will be to let users conceptualize affordances descriptions themselves. This could certainly yield some interesting results. Also in this study the affordances to choose from were limited to each task. It would be certainly interesting to see which affordances emerge when fuller freedom of choice or conceptualization is given to users.
3. It could be interesting to see if there are some interdependencies between various affordances. There is a wider perspective for discovering how affordance networks function in practice.
4. Registering participant names (as was actually done in this research) would allow to link different variables related to them (for example, academic performance) with affordances that are actualized from their point of view. It could be possible to gather information on certain patterns in how different groups of people with different characteristics perceive affordances in the same system (see 2.1.3).
5. Given the wealth of information that an open source web app such as LePlanner could provide, it could be worth effort to explore real usage data for elements that were associated with affordances in this study, and compare it with what users have perceived. It could also provide more ways for discovering the LePlanner specific affordance networks.

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7. Appendices

7.1. Appendix 1. LePlanner screens with the interface elements taking part in the survey highlighted

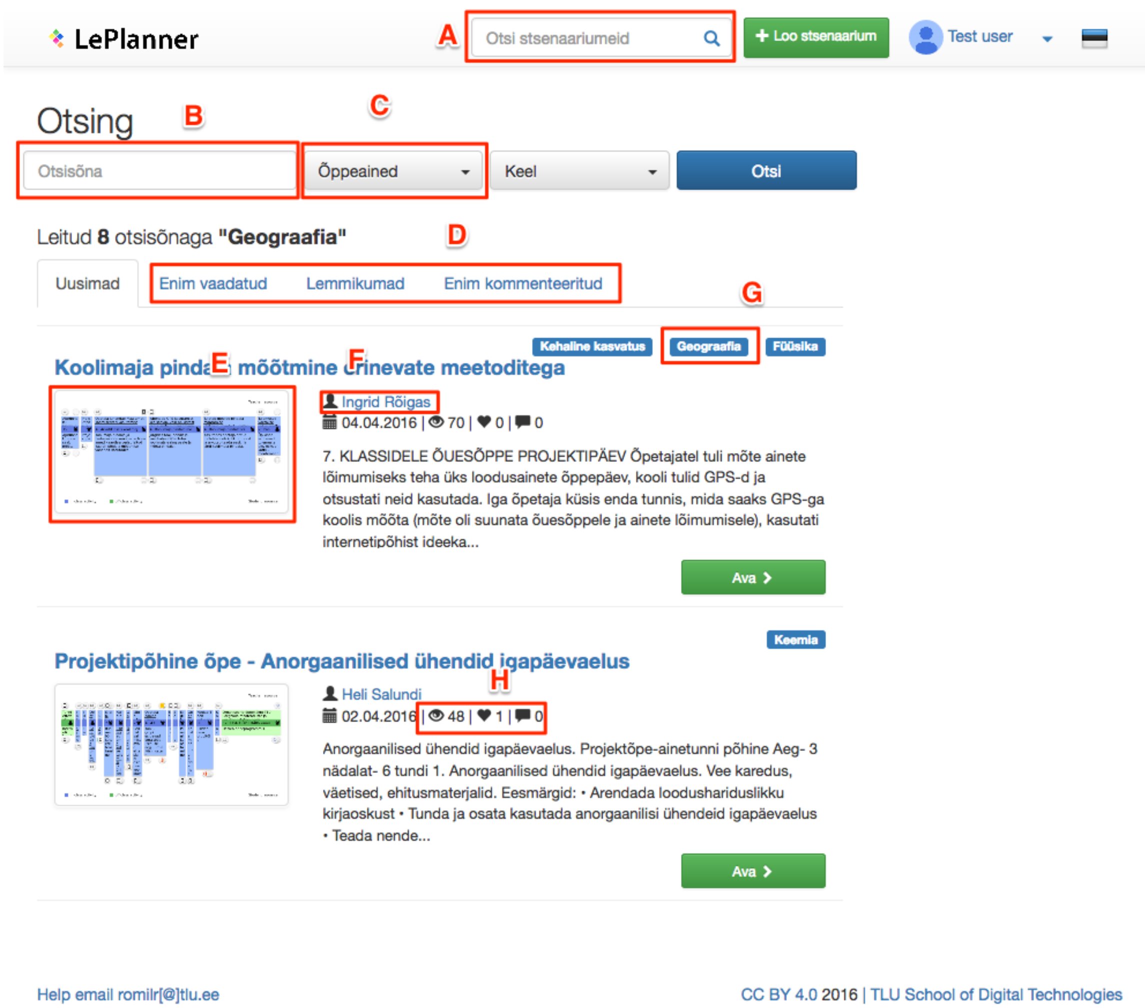


Figure 14. Task 1, screen 1 — Search results

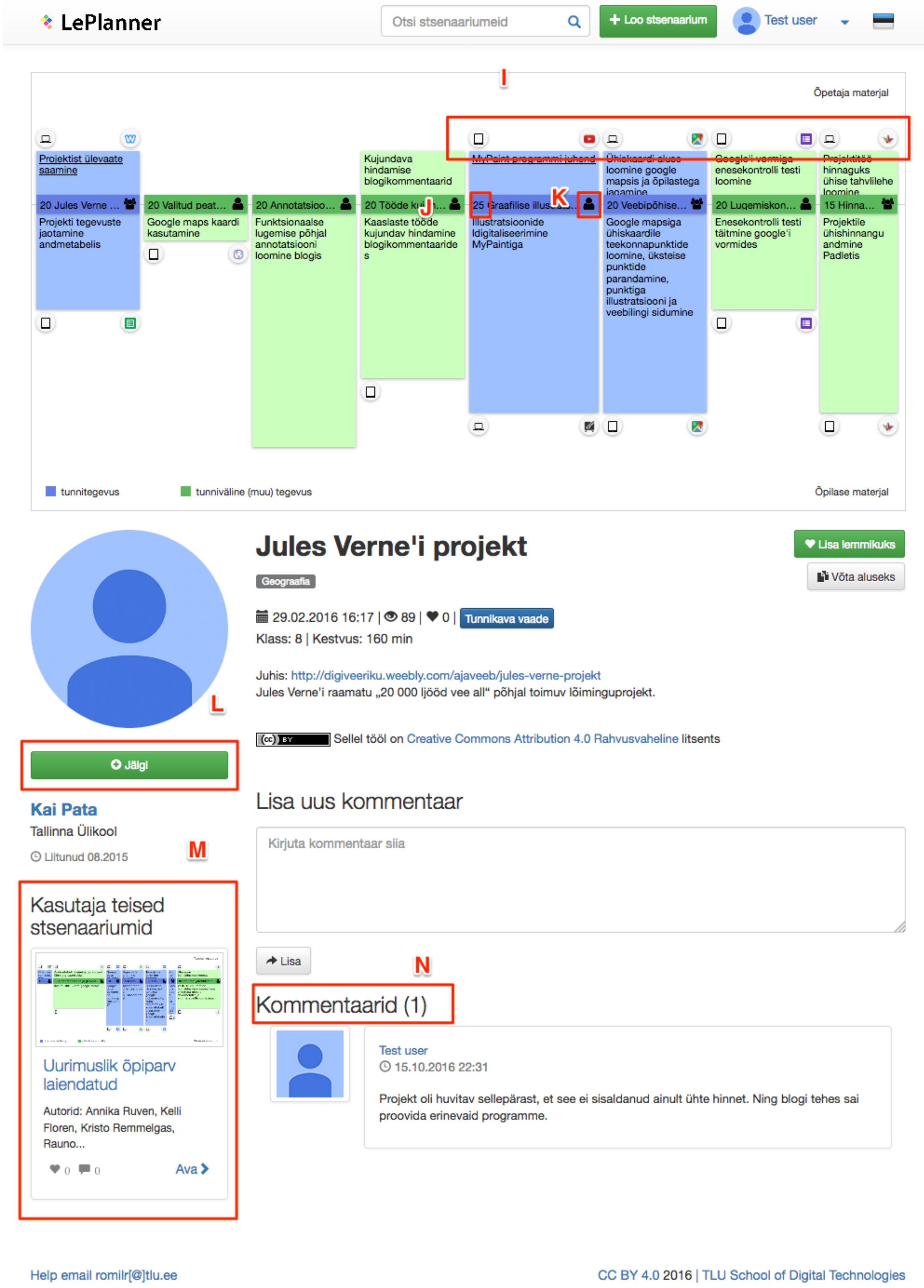


Figure 15. Task 1, screen 2 — Scenario — Timeline view

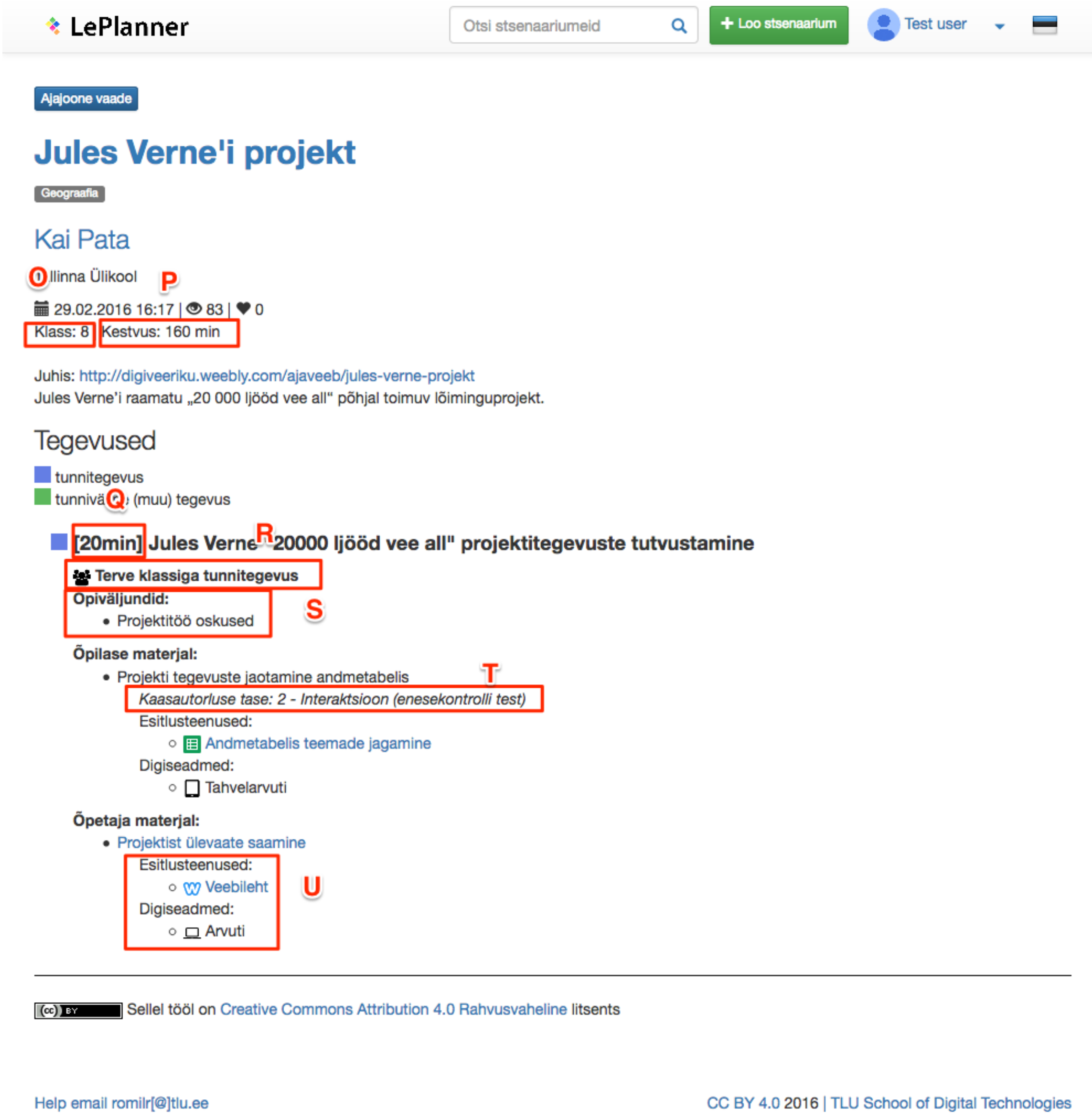


Figure 16. Task 1, screen 3 — Scenario — Text view

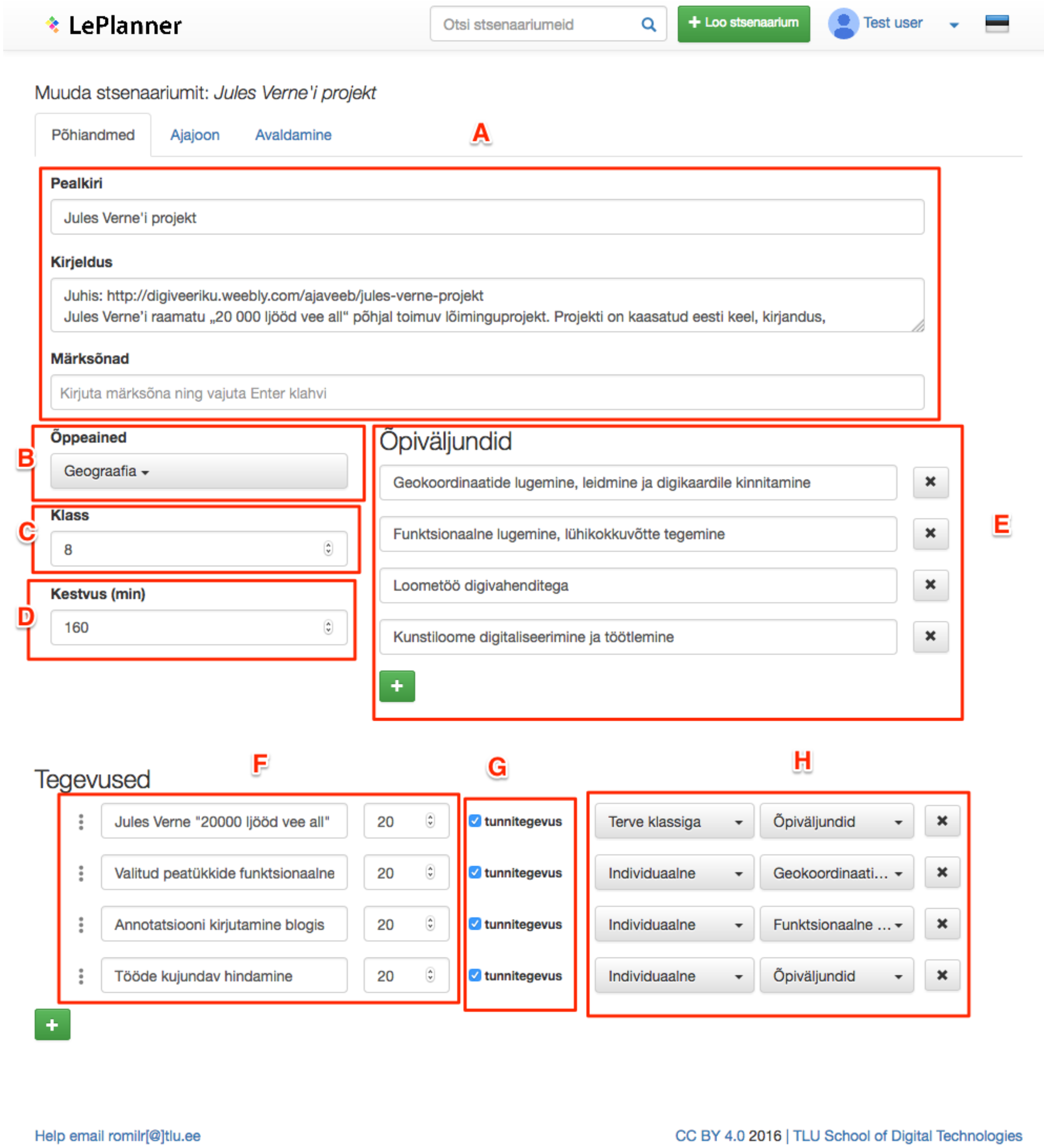


Figure 17. *Task 2, screen 1 — Scenario — Edit details*

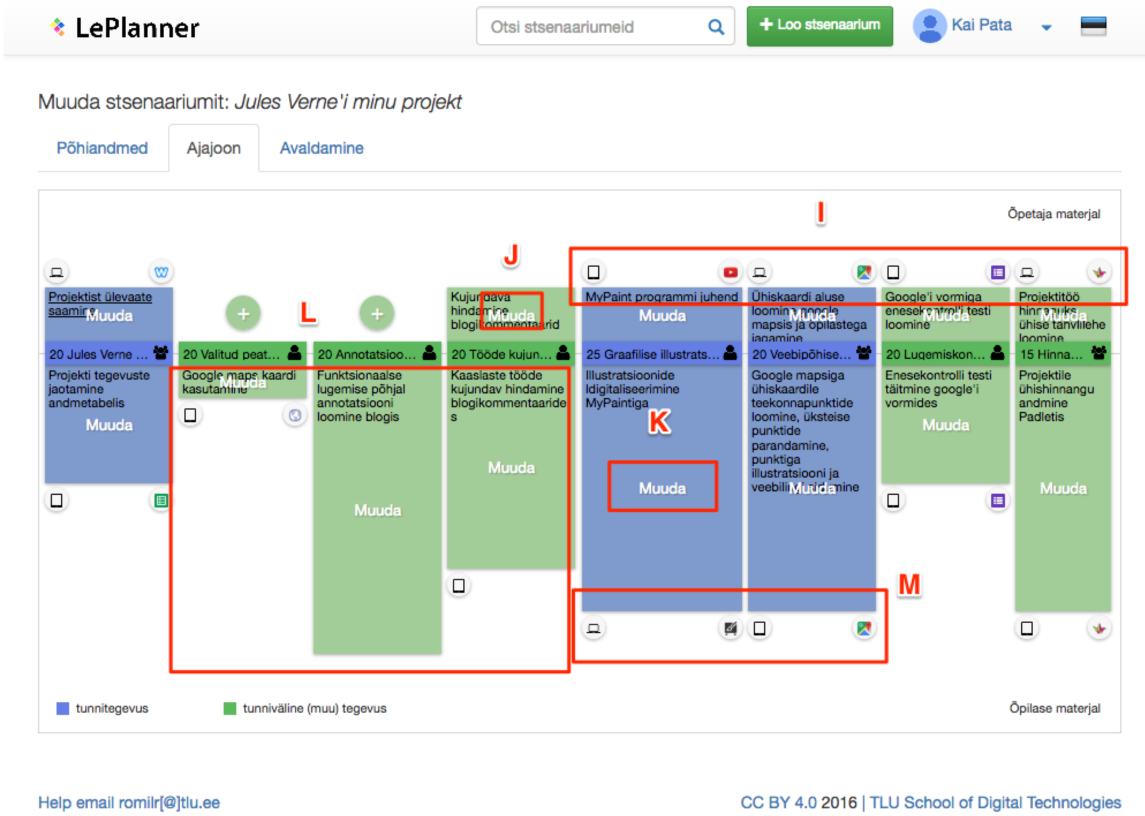


Figure 18. *Task 2, screen 2 — Scenario — Edit timeline*

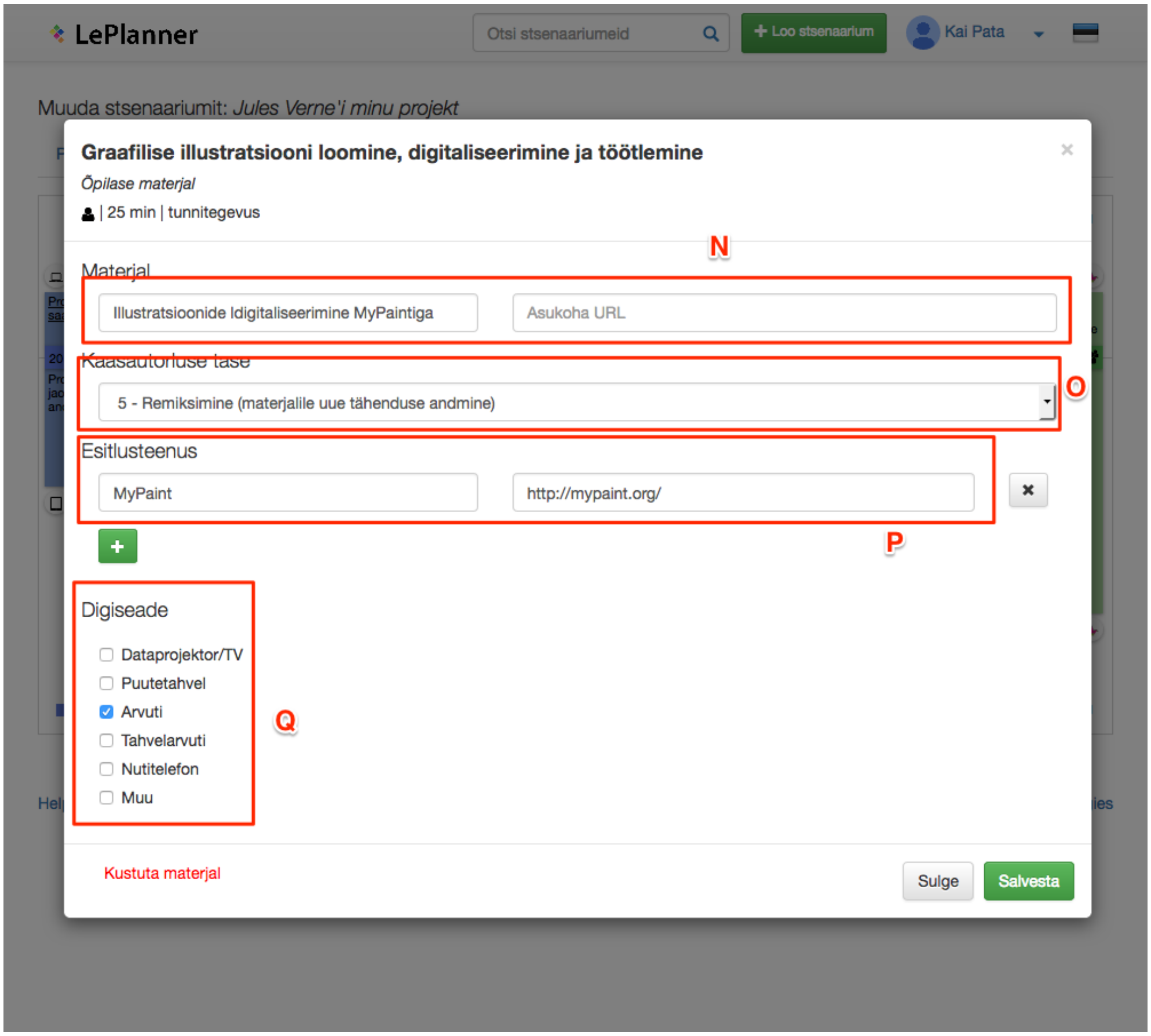


Figure 19. Task 2, screen 3 — Scenario — Edit timeline resources

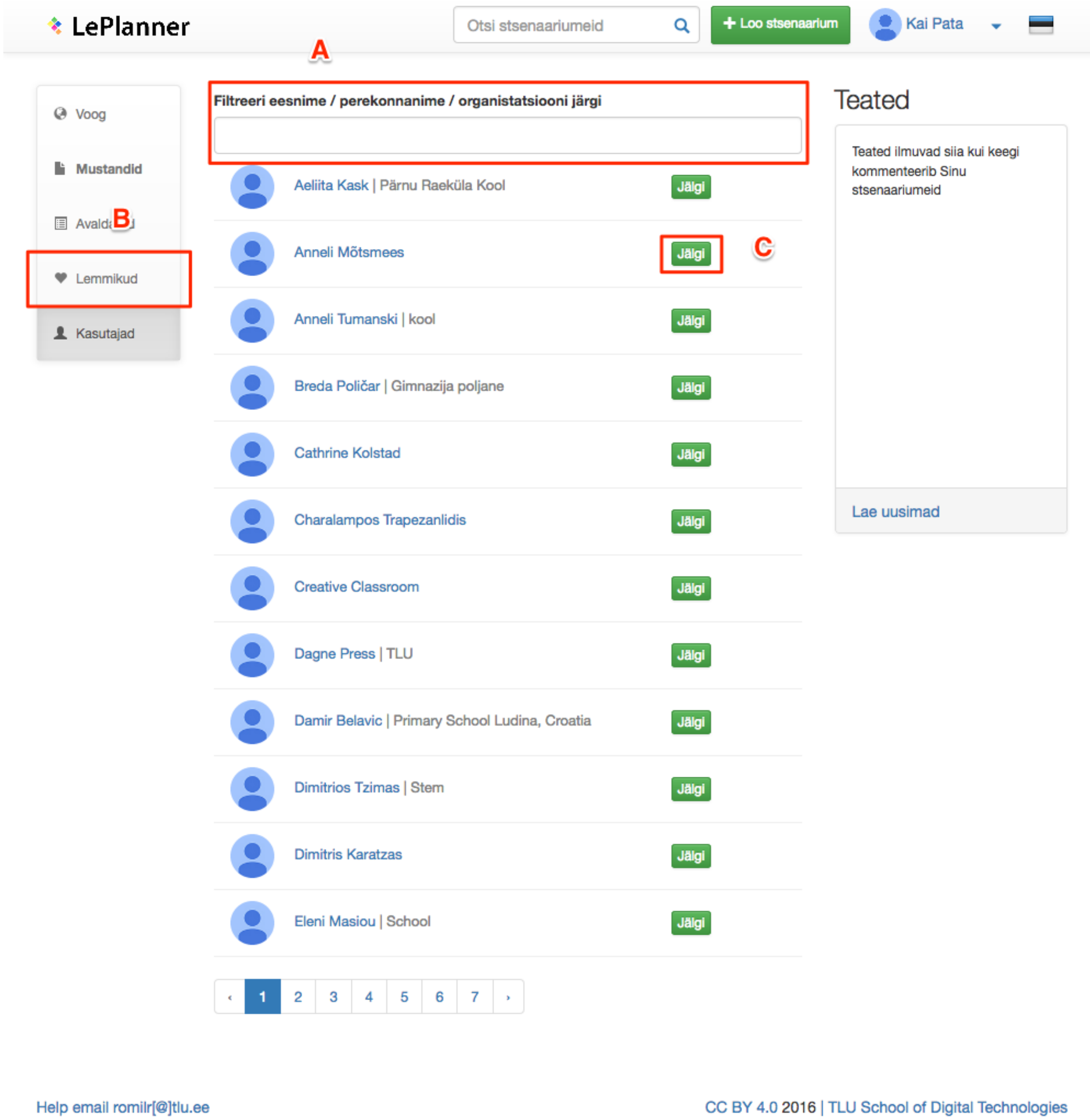


Figure 20. *Task 3, screen 1 — Users list*

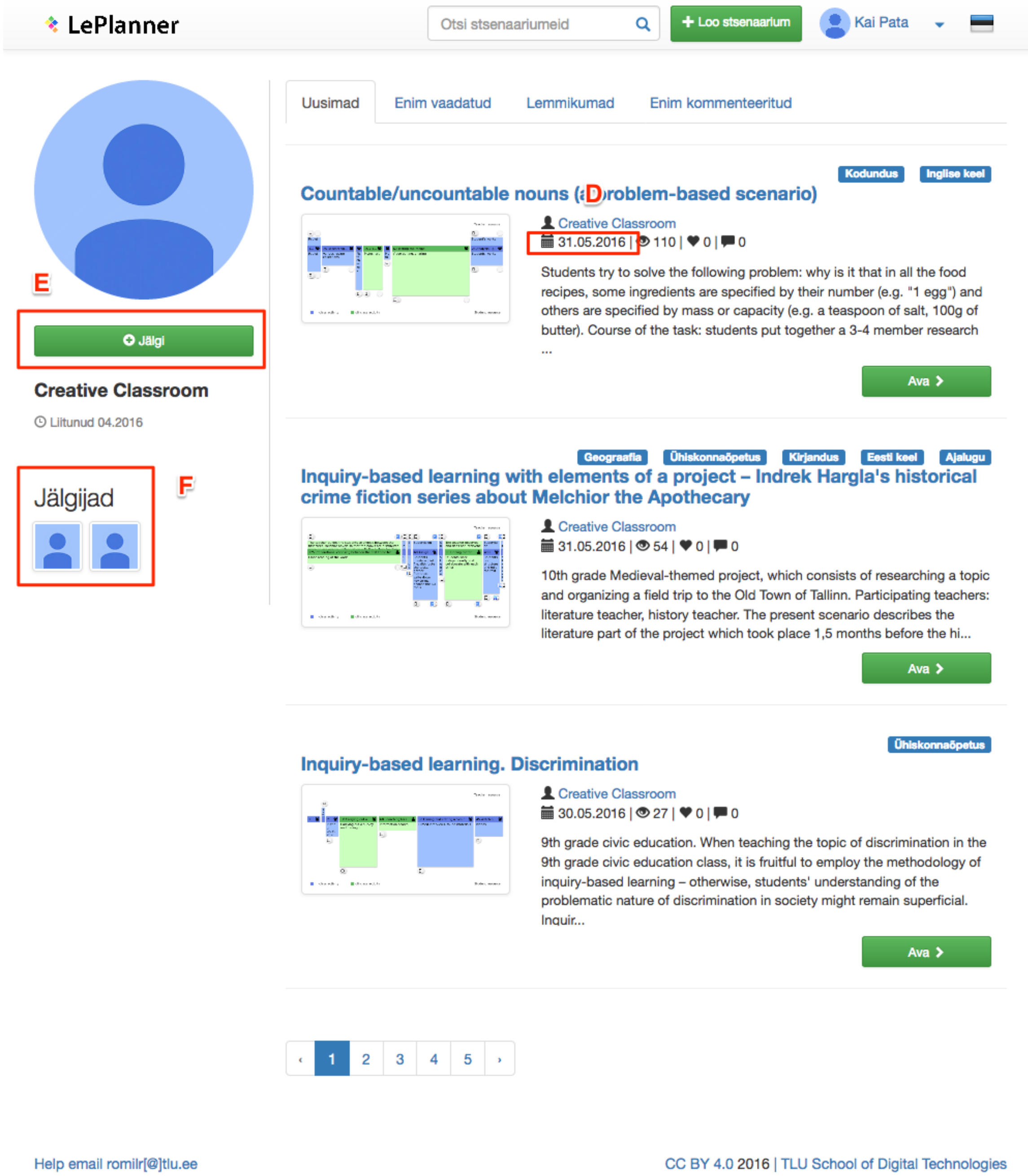


Figure 21. *Task 3, screen 2 — User page*

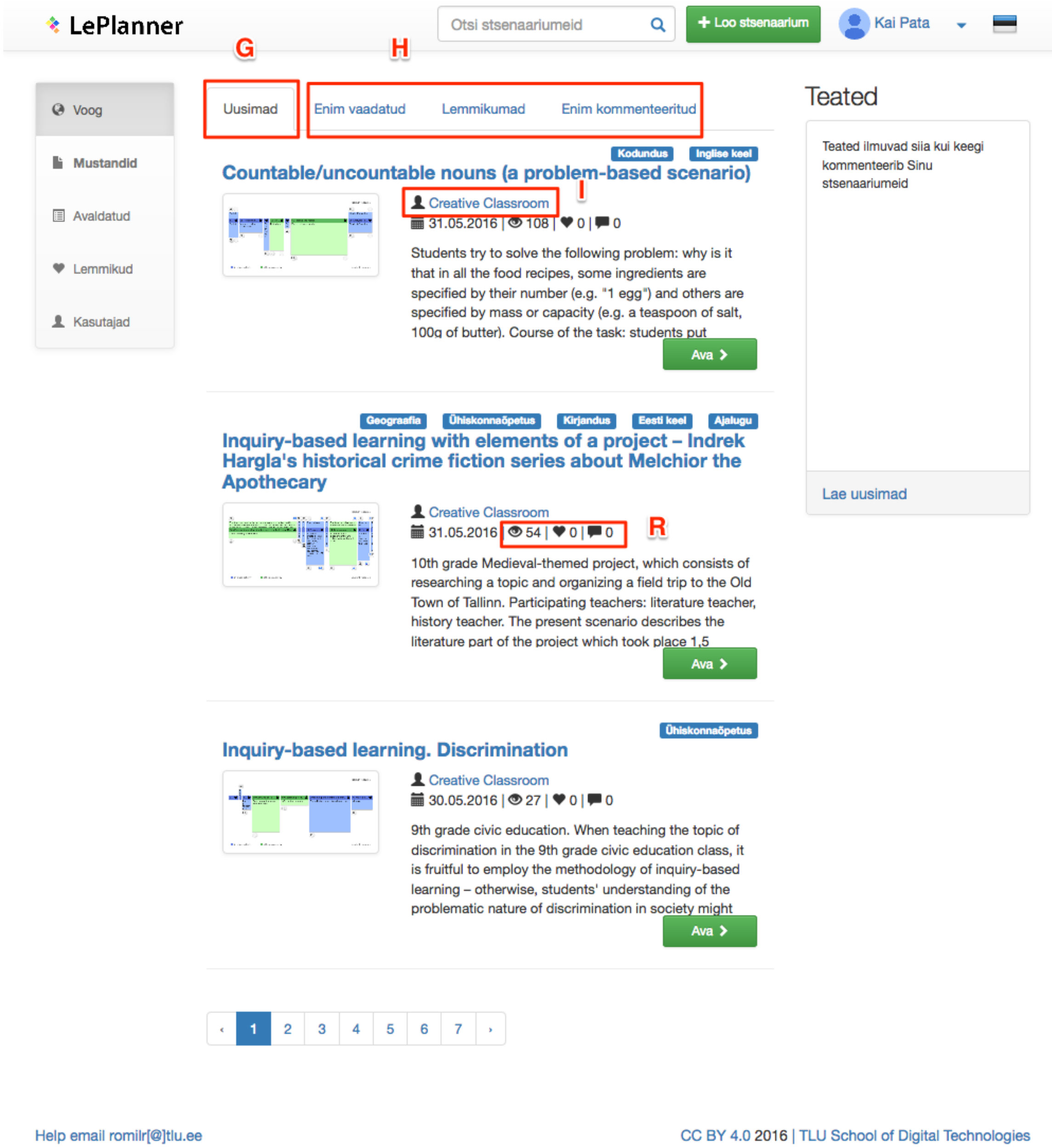


Figure 22. Task 3, screen 3 — User feed

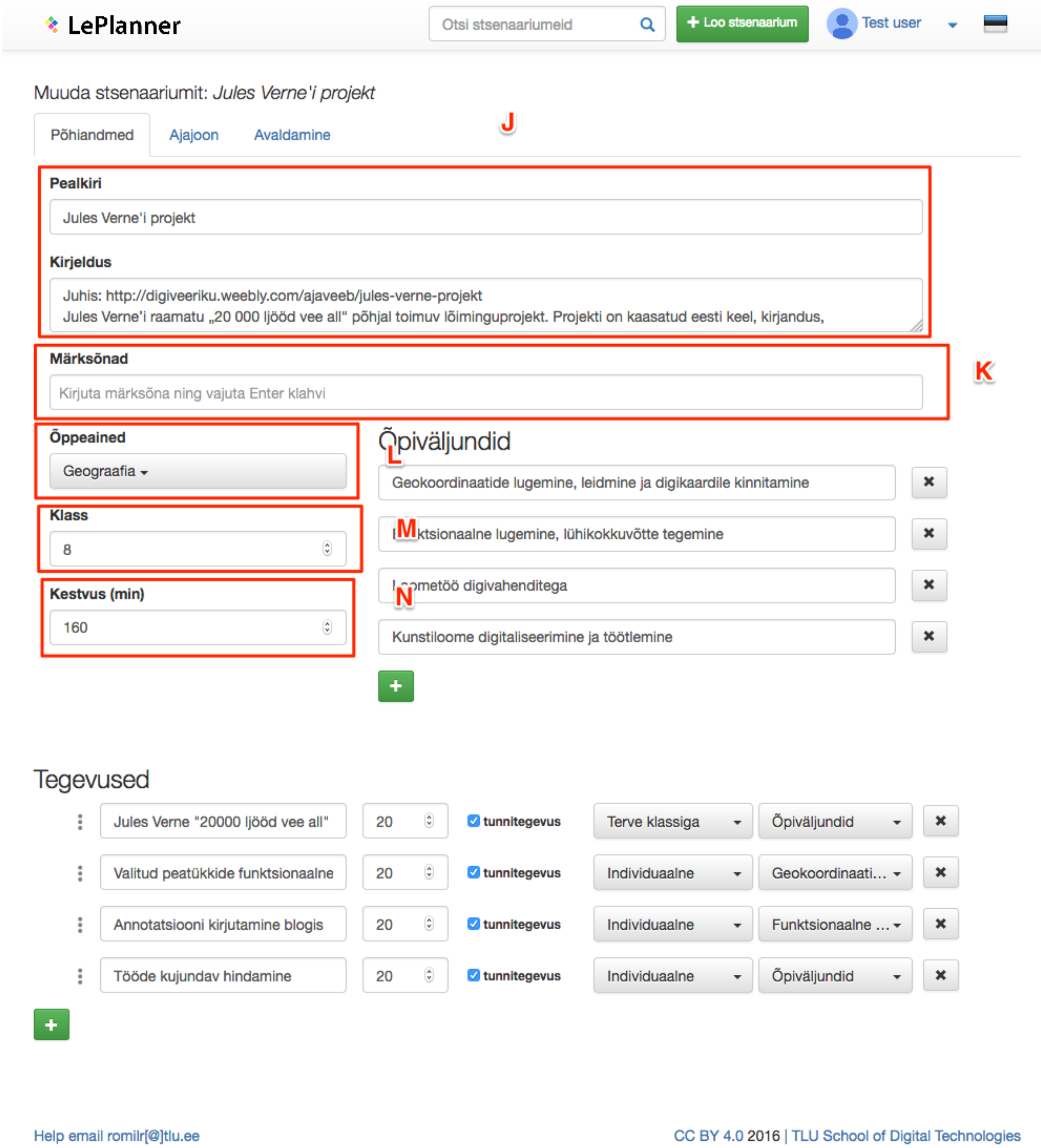


Figure 23. Task 3, screen 4 — Scenario — Edit details

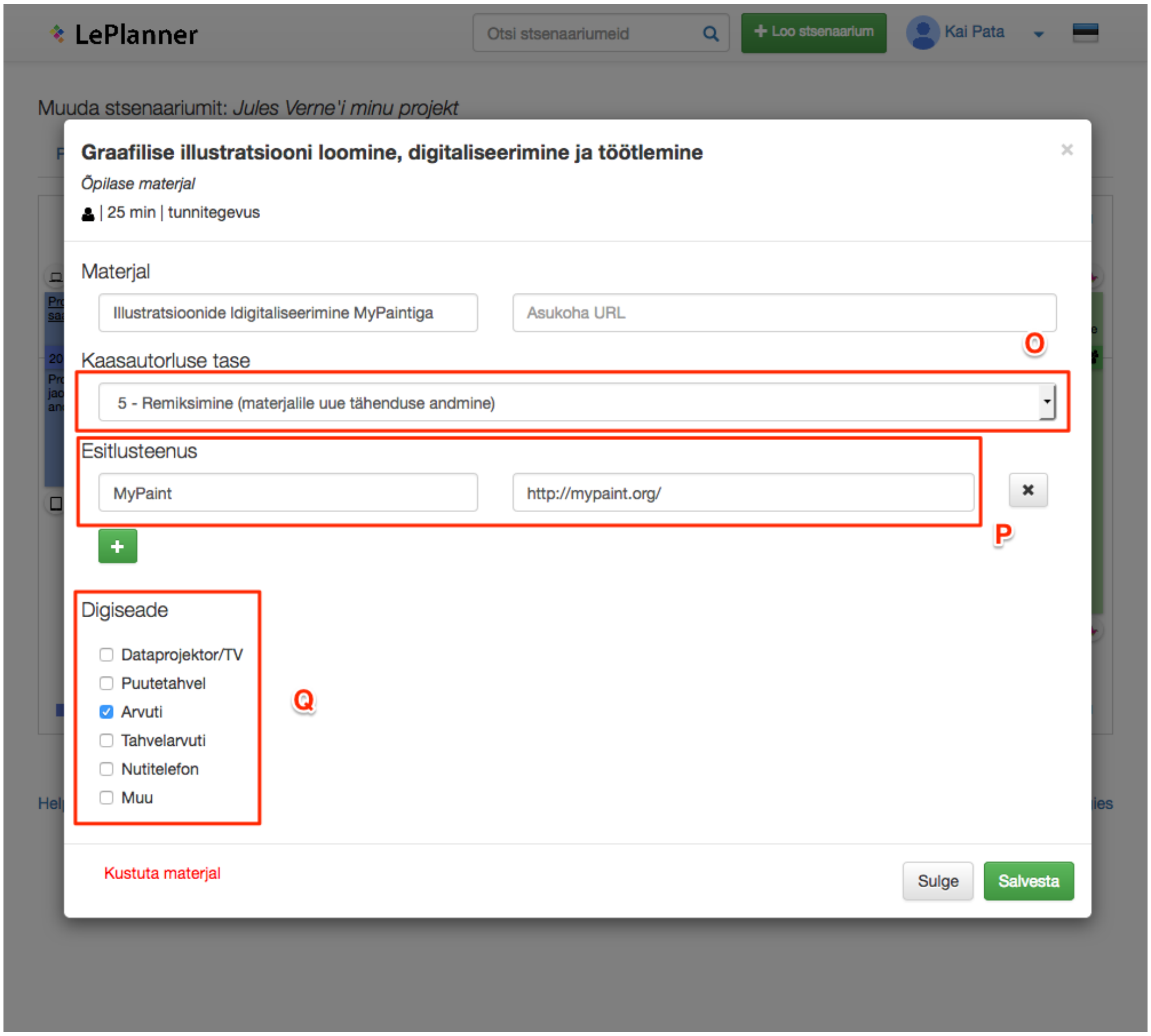
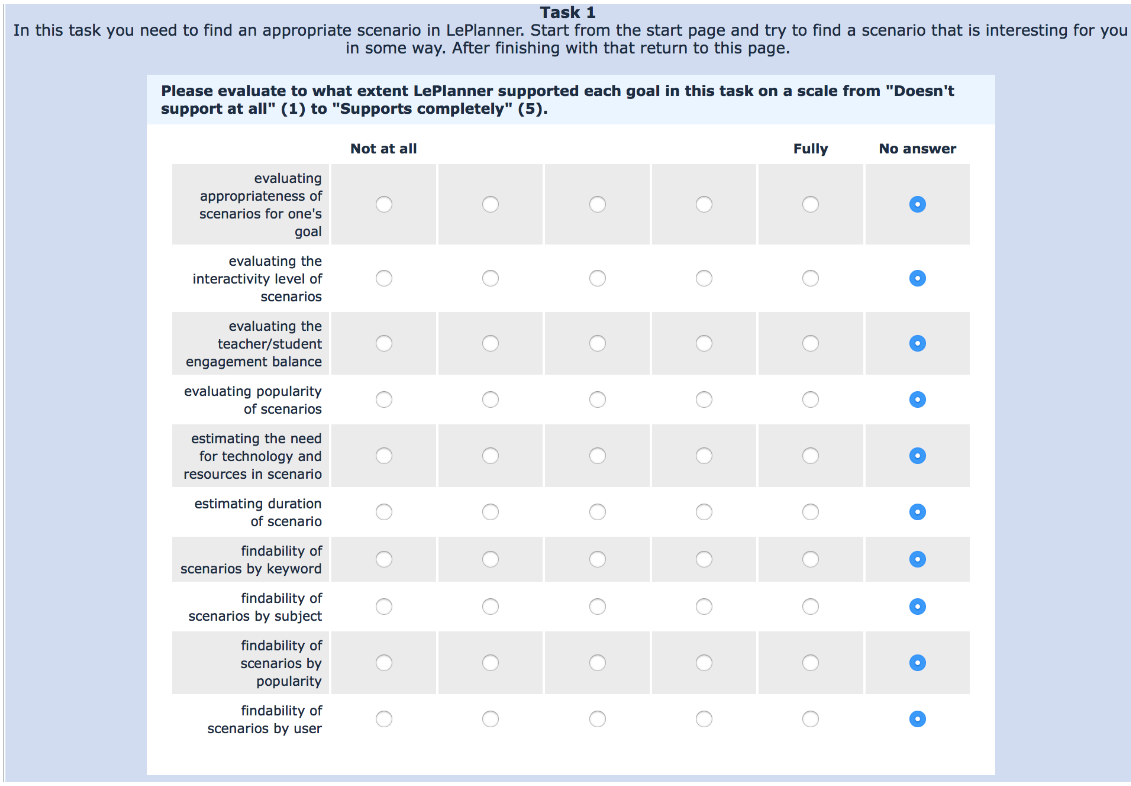


Figure 24. Task 3, screen 5 — Scenario — Edit timeline resources

7.2. Appendix 2. Survey questions



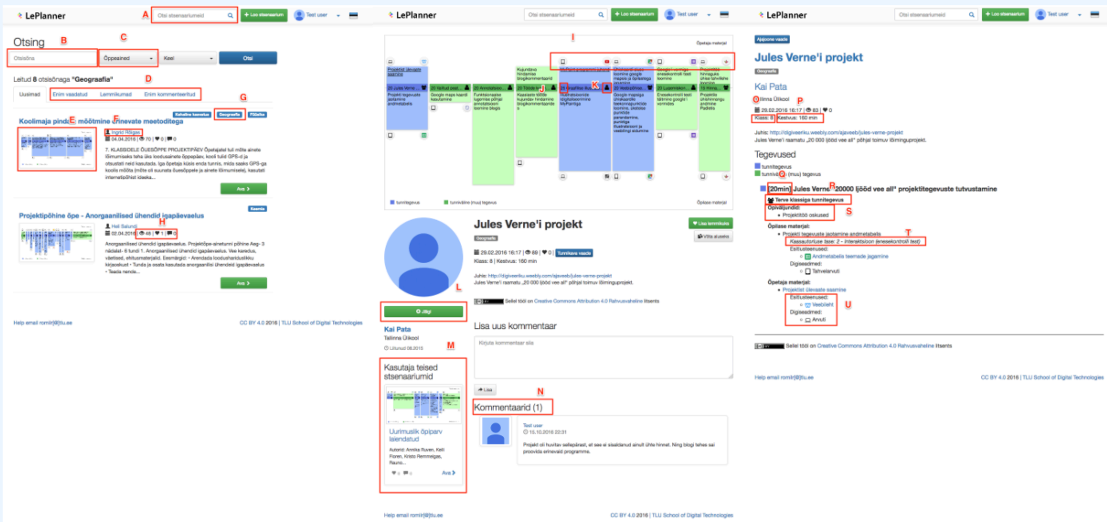
Task 1

In this task you need to find an appropriate scenario in LePlanner. Start from the start page and try to find a scenario that is interesting for you in some way. After finishing with that return to this page.

Please evaluate to what extent LePlanner supported each goal in this task on a scale from "Doesn't support at all" (1) to "Supports completely" (5).

	Not at all				Fully	No answer
evaluating appropriateness of scenarios for one's goal	○	○	○	○	○	◉
evaluating the interactivity level of scenarios	○	○	○	○	○	◉
evaluating the teacher/student engagement balance	○	○	○	○	○	◉
evaluating popularity of scenarios	○	○	○	○	○	◉
estimating the need for technology and resources in scenario	○	○	○	○	○	◉
estimating duration of scenario	○	○	○	○	○	◉
findability of scenarios by keyword	○	○	○	○	○	◉
findability of scenarios by subject	○	○	○	○	○	◉
findability of scenarios by popularity	○	○	○	○	○	◉
findability of scenarios by user	○	○	○	○	○	◉

Figure 25. Survey example (Task 1) question 1



Please check the appropriate checkboxes if an element on the screenshot supports a certain affordance.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
estimating appropriateness of scenarios for one's goal																					
estimating the interactivity level of scenarios																					
estimating the teacher/student engagement balance																					
estimating popularity of scenarios																					
estimating the need for technology and resources in scenario																					
estimating duration of scenario																					
findability of scenarios by keyword																					
findability of scenarios by subject																					
findability of scenarios by popularity																					
findability of scenarios by user																					

Figure 26. *Survey example (Task 1) question 2*

7.3. Appendix 3. Survey results — question 2

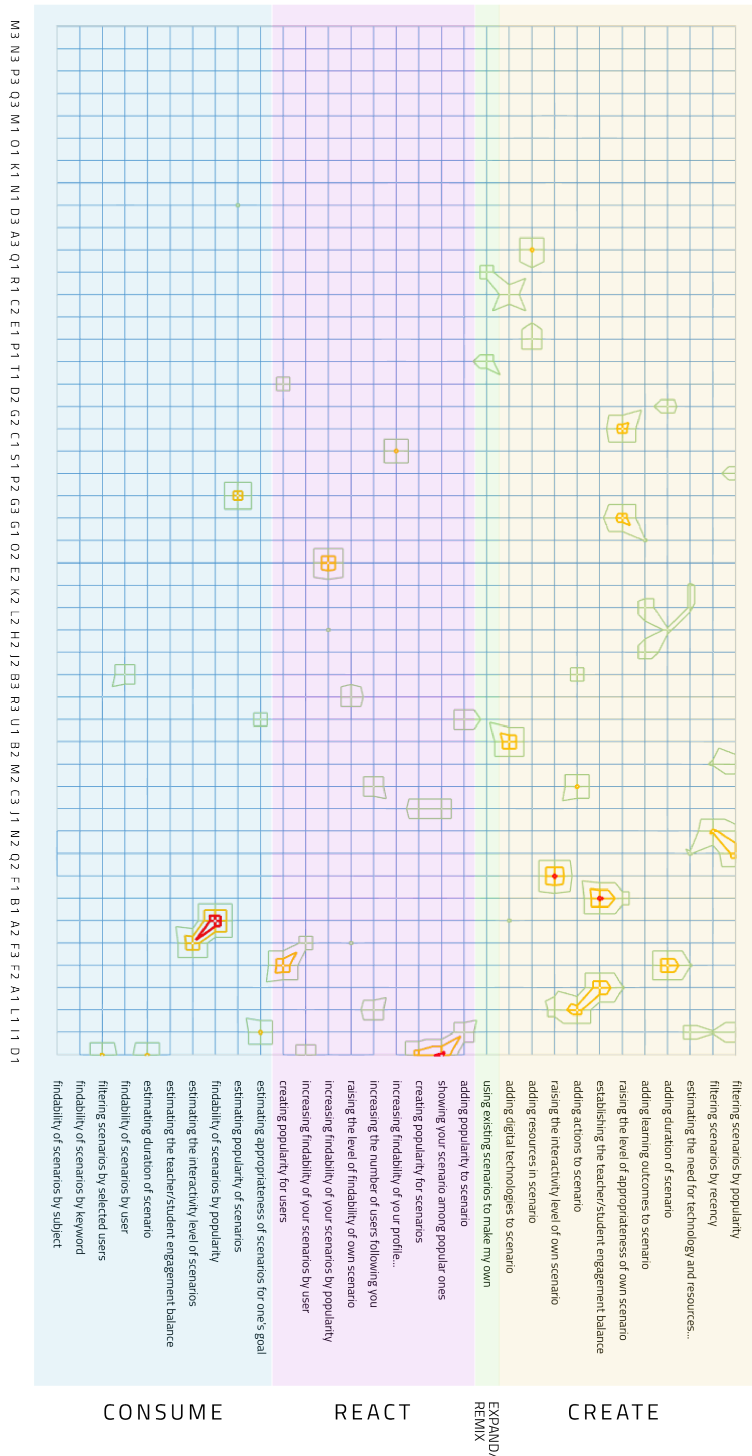


Figure 27. Interface elements of LePlanner associated with specific affordances for all 3 tasks