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Abstract Societies are changing rapidly because of automation and digitalization, but local and global business environments are also becoming more volatile. Changing societies also place requirements on education: the number of atypical learners is growing all the time, and lifelong careers have been changed to lifelong learning. Traditional education approaches do not support part-time learners or lifelong learning; personalizing the learning process for every student separately is too laborious. In this paper, we study a flexible, personalized learning approach and an information system (Wihi) to support it. Wihi is a thesis management tool for students to plan and schedule their theses and for the thesis supervisor to centrally monitor the progress of different theses. In addition, it allows curriculum management to follow the whole thesis situation. Although Wihi was developed for a specific need, the personalized learning assumptions behind it are also applicable in other education cases.

Keywords: digitalization, personalized learning, digitalized teaching processes, lifelong learning, thesis.

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1 Introduction

It has been estimated that, due to digitalization and automation, a remarkable share of jobs is vanishing (Wike & Stokes 2018). At the same time, for the same reasons, new jobs are emerging and new skills are needed. In addition, today's economy is more volatile than it used to be and changes anywhere in the world are affecting societies faster and heavier than before. The only constant in the world is change.

This means that, to adapt to the change, individuals must be ready to study new skills frequently. When digitalization and automation remove jobs that are monotonous and easy to automate, the new ones are much more complicated and require deeper learning from employees (Wilson, Daugherty, & Morini-Bianzino 2017). The education that was enough for a good job a couple decades ago will not be enough for today's work environment. Lifetime careers are no longer a presumption. More often, individuals have to learn several different professions during their lifetimes. In addition, it seems that the Z generation is not even interested in lifelong careers; they want to have change and new challenges.

Thus, there is a need for personalized learning solutions. Students should be able to plan the main targets, necessary skills, and learning objectives of the studies, as well as the stages and schedules of the study, independently from the semester term or period. In some situations, the study target can be graduation, but often the same students just need to learn some new skills to outperform in their profession; the emphasis may change rapidly. Schools and universities should not restrict the students. Full-time, part-time, time-independent and continuous learning should be possible for all students.

However, lecturers' and professors' working time is not enough to follow and guide each separate student's objectives, selections, and progress. Likewise, their tools do not support personalized teaching: student registers and e-learning platforms are built on the idea of courses and curriculum (see e.g. Dirin & Laine 2018), and other tools like Excel are too generic and not interactive at all.

New kind of flexibility was the main target when Wihi, a new system for supervising thesis projects, was developed in Haaga-Helia UAS (University of Applied Sciences). Before Wihi, the thesis process was managed with spreadsheets, emails, and documents submitted to e-learning platforms such as Moodle and Blackboard from time to time. Since students conduct different kinds of development and research projects for their theses, they all have separate plans, tasks, and schedules. With the previous systems, it was difficult for teachers to follow the progression of students, for students to get comments, feedback, and guidance on time, and for thesis coordinators and other management to see what the whole situation is: how many students will graduate and whether there is a need for special arrangements (supporting courses, etc.). Thus, the idea was to create a thesis specific IS (Wihi) providing support for personalized thesis projects so that they still follow the thesis process and its guidelines of Haaga-Helia UAS.

The challenges of the thesis process have been recognized, and some related work has been done in both the areas of quality improvement and IS support (Aghaee 2015; Karunaratne 2018; Lagstedt 2015). A thesis process support system similar to Wihi is SciPro and Hansen and Hansson (2015) have studied student-supervisor interaction with it. But, previous works do not focus on personalization aspects.

To find out how well the developed IS (Wihi) answered the personalized learning needs of thesis process, the following research questions were formulated: **RQ 1:** *How and to which extent did the IS innovation project (Wihi) resolve the problems that occurred in the old thesis process supporting personalization?* **RQ 2:** *Which way the new IS was able to enhance the process handling and understanding from students' and teachers' perspective?*

2 Theoretical background

Teachers may use new technologies only as a substitute manual tasks, or they can take totally new digitalized processes in use (Jude, Kajura, & Birevu 2014). As personalized learning requires the latter, more challenging approach, it is important to evaluate what aspects affect students' and teachers' actions.

A thesis process is an example of a problem-solving project where student gains better comprehension of the chosen topic. Here, we follow Pritchard and Woollard's (2010, 89) definition of constructivist learning theory: a learner constructs one's own understanding by selecting and transforming information (past and present) in order to gain new personal knowledge and understanding.

2.1 The nature of learning processes

Especially higher-level students construct their own study paths. Alternatives are available from both content and pedagogical approaches. A university itself normally defines the nature and scope of the thesis. The university sets, for example, reporting standards and the format of the thesis. Otherwise, a student has a lot of freedom to design and execute the process, and a teacher has rather a supporting than an advisory role. Situation like this can be classified as Mezirow's "communicative learning" (Mezirow 2012, 77), which in turn is based on Habermas' categorization of instrumental and communicative learning.

2.2 Motivation

In Self-Determination Theory (SDT) motivation is distinguished between two categories; *intrinsic* and *extrinsic* (Ryan & Deci 2000, 55). A thesis is as an example of extrinsic motivation, especially a commissioned one, since it enables graduation as an external reward. However, sometimes the thesis project may halt for different reasons, not always because of the student's own. It is much easier to continue if also the intrinsic motivation is high; Ryan and Deci (ibid., 55) remind that intrinsic motivation leads to higher level of learning and creativity. Naturally, high self-discipline or commitment and a strong routine may compensate for the lack of motivation, but with most people, the inner motivation is the driving force.

Keller's (1987) ARCS model of instructional design can be used to operationalize motivation-related ideas. In learning, the first condition is *attention* (ibid., 3). Attention is built in the thesis process: students can choose topics from the area of their own interest. The second attribute in the model is *relevance* (ibid., 3). This is also covered in a thesis process both because of the topic selection and because of the importance of the thesis for the degree studies. When attention and relevance are more like prerequisites of motivation, it is also important to sustain a high level of

motivation, especially in a long-lasting project such as the thesis. *Confidence* (ibid., 3) is higher in some people who have a higher likelihood of success. This feature, related to self-esteem, can be supported by proper counseling and feedback (see section 2.4). The fourth component, *satisfaction*, has its origin in behavioristic reinforcement (ibid., 3). Successfully completed tasks or phases and positive feedback from the supervisor increase satisfaction.

2.3 From Autoregulation to Self-directedness

In relation to motivation theory, self-regulation or autoregulation, as e.g. Leontiev prefers it (Leontiev 2012, 94), explains the mechanisms that regulate human behaviour. In the context of pedagogy, this can be formulated as self-directedness. According to Breed (2016, 3), self-directed learning (SDL) requires student to figure out the learning needs and strategies to learn in order to meet his/her goals. Breed continues that some other researchers (e.g. Guglielmino; Brockett and Hiemstra) put more weight on the learners' characteristics. This leads the discussion back to self-determination and intrinsic motivation (see section 2.2), as well as, problem-based learning, which is in line with the nature of thesis process.

2.4 Feedback

Even if behavioural learning theories are mostly superseded by cognitive psychology and constructivism, the reinforcement appears in motivation theories (e.g. Keller 1987). Immediate feedback is the most efficient. The challenge of the thesis is that the feedback is often directed to faults and deficits in the report, which sets a need for constructive feedback that does not demotivate the student to continue. Based on the feedback of graduating students (The Ministry of Education and Culture and the Finnish National Agency for Education 2020), some students feel that they do not get constructive feedback or that feedback is given too late, when the project is in its final stage, so not much can be done if the problems are fundamental.

The students' behaviour may vary from a type of student who is highly independent with high self-esteem and is, therefore, not interested in feedback. Some may even get irritated if a supervisor is too keen on giving feedback (see also Keller 1987, 6). Illeris (2009, 16) even mentions mental resistance, which may block or distort learning. In a thesis work, a student may have already put all the effort into the

report, and feedback that would require changes may be too much to handle. The other extreme are students who are unsure about their decisions, so, they continuously want feedback on all the details. Without the requested response from the supervisor, a student may halt the process. Therefore, it is vital for a supervisor to manage the feedback and keep it at optimal level.

2.5 The role of the teacher

The roles of the thesis supervisor and the student could be compared to the apprenticeship model. In this setting, the knowledge and skills are transferred from a master/supervisor to an apprentice/student (Pritchard & Woollard 2010, 16-17).

Thanks to the Internet and modern libraries, the students have access to the same sources of information as teachers. However, in the thesis process, there is still a need for traditional tutoring in order to gain intellectual and cognitive growth, as Lev Vygotsky would express it (Pritchard & Woollard 2010, 14). This is easy for a professional teacher, but the systematic follow-up of every thesis project (each with their own schedules) is challenging. Different spreadsheets and calendar applications are needed to deal with the situation. This is especially challenging, when one thesis supervisor may get, for example, a group of ten new students twice a year to be supervised, and simultaneously, earlier students may have projects pending in different phases. In this situation, e-mail communication is scattered in the supervisor's mailbox, with intermediate versions either as attachments in emails or saved in supervisors' folders. In these kind of situations some students needing more attention go easily unnoticed, which might lead to a delayed process or even to the students' dropping off their projects or their studies altogether.

3 Methods

3.1 Case: Thesis Process and Wihi

The thesis process was digitalized, and Wihi was developed applying an expert oriented digitalization model EXOD (Kauppinen, Lagstedt, & Lindstedt 2019). The EXOD model has four phases: initiation, process and IS re-engineering, IS development and stabilization. Data used here is from the first three phases.

In its initiation (before 2014), Haaga-Helia UAS described its core processes, revealing that the thesis process was one of the most complicated. In the second phase, the process was re-engineered during 2014–2017. In the third phase, Wihi was developed during 2016–2019, and changes to the learning process were implemented and communicated. After the fall 2018 test period, Wihi was launched into full use in January 2019 starting the stabilization phase.

3.2 Research Method

In the case study research, we followed the recommendations of Yin (2009). We extensively used the four data collection sources (documentation, archival records, participant observation, and interviews) that Yin (2009) recommends. Since one of the researchers was responsible for the thesis process development and another for the development of the IS (Wihi) supporting it, we had access to both the process and IS development documentation. We also utilized (for both RQ 1 and 2) Wihi's logs and registers (over 400 cases available) as supporting data to understand the actual IS usage. As thesis coordinators and supervisors, we also used (for RQ 2) Wihi to make participant observations. Eight thesis supervisors and six students were interviewed in May 2019 representing the active user perspective in both on applying the personalized learning process and in using the IS (Wihi). In the analysis, the main emphasis was on the interviews (n = 14, the number of interview questions was 20 consisting of 3 background variables and 17 research variables). The other sources, such as the minutes of the university-level thesis coordinators' meetings, feedback that was converted to prioritize design plans, task force (core designer group) meeting summaries, and initiatives from staff, were considered complementary data (for RQ 1).

During interviews the example of Dahlberg, Hokkanen and Newman (2016), was followed; questions were presented onscreen, either face-to-face or via a video call and answers were typed and presented right away. This allowed the interviewees to validate the typed answers immediately. The method allowed us to easily assess the saturation after each interview. The content analysis was done by using Excel.

4 Results

4.1 Re-engineered learning process in Wihi

The re-engineered thesis process has seven phases, from the approval of the topic to the completion of the thesis process (Figure 1). The student-supervisor–oriented learning process is most active from project planning and scheduling to the finalization of the thesis report (phase "Thesis 3/3"). The student can plan and set the schedule for these phases, thus providing a way to create their own path through the thesis process and plan the schedule (see 2.1) for it, reinforcing the feel of ownership and motivating the students to follow the plan (see 2.2). This is also supported by tasks that the student can create for the phases and that they can follow by updating their status (2. Current phase), meaning that the student can set intermediate goals (see 2.3) that are visible and that their status can be monitored by both the student and the supervisor.

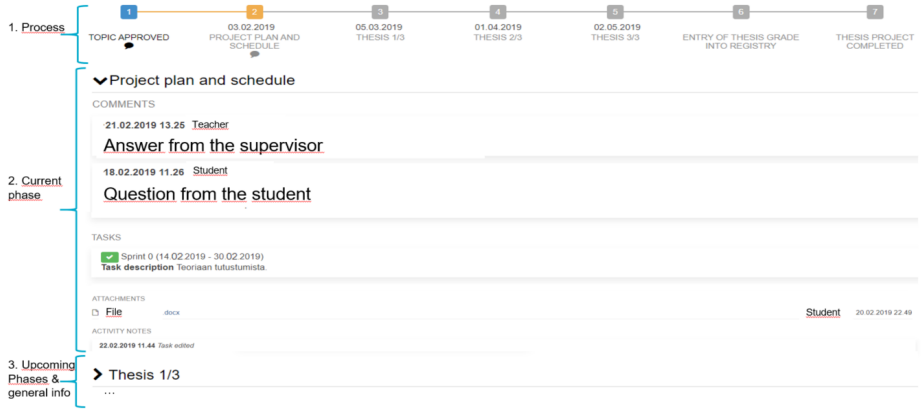

Figure 1: Supervisor's view in Wihi in a situation where a student is currently planning the thesis project and its schedule. The division of the view in three parts on the left is added for clarity.

Because the learning process in the thesis work follows the apprenticeship model, effective communication, feedback, and systematic follow-up are critical in each phase (see 2.1, 2.2 and 2.5). In Wihi, communication between the student and the supervisor is possible using messages (comments) and by attaching relevant files for the current phase (2. Current phase). This can also be used for feedback and

systematic follow-up and, in addition, it is possible for the supervisor to use activity notes. Some activity notes are generated automatically, and the supervisor can add some from neutrally worded, predefined options such as "the work is progressing as expected."

Completing a phase in a thesis is a concrete milestone in the learning process. In Wihi, when the student has completed the task planned for the phase, they communicate with the supervisor, who accepts the phase; this results in the current phase being changed in Wihi. This is a way to control and monitor the progress of both the learning process and the overall thesis process. In addition to the supervisor's control, Wihi performs automated uniform checks for all the thesis processes, such as an enforced plagiarism check before grading. Upcoming phases are visible during the entire process (Figure 1, 3. Upcoming phases & general info) as is general information, such as student information, the topic description and other relevant information related to the thesis.

Overall, Wihi provides a student-specific portal (see 2.5) where the thesis process is planned, executed, and assessed. The learning process is owned by the student (see 2.3) and supported by the supervisor. Wihi also provides visibility and objectivity to the process (see 2.4) since, for example, the communication and progress of the process is documented there.

4.2 Student and Supervisor Experiences

Students and supervisors stated that the most positive characteristics of Wihi were the visual clarity and holistic view to the learning process; everything dealing with the process was on the same view. Most interviewees also mentioned seeing specific improvements in the process, either in entire phases or in certain details of them (see 2.3); the final phase is now clearer (student), and assessment is now done within in the same system (supervisor). In addition, some mentioned characteristics like process automation; credits from the thesis being transferred to the study register system automatically, streamlined process, process guidance, and enforcement; certain steps being mandatory, easier communication; connecting the student and the supervisor; and overall ease of use.

For negative features, the highest number of answers cumulated to the opinion that the system did not have a certain desired function or that the feature did not function as the user expected. Some interviewees also felt confusion at some point, typically over a technical problem; do the credits really transfer to the study register system (supervisor); in phase 1/3, there are several opportunities to hand in the report (student). Most supervisors and one student interviewee had detected some sort of resistance to change; many students still send emails (supervisor).

Based on the answers, the process has been improved and is now more transparent (see 2.4); Wihi reduces the confusion (student); the plagiarism check is now used for 100% certainty (supervisor); the monitoring of student processes was more difficult without Wihi (supervisor).

The interaction between students and supervisors (see 2.1) has also improved, according to all interviewees; the interaction is more organized now (supervisor), but many still stated that there has been no change. Some negative aspects were also reported; If the university's email address is not used, the notices sent via Wihi at the beginning of the process are not received (student); the text editor in Wihi is not at the same level as email (supervisor).

The students were asked if the communication with the supervisor is easier using Wihi than with standard emails. Of the six students, two gave only positive aspects, two did not see any difference, and one replied that, from a process point of view, it is handy that everything is in the same place (see 2.5), but some other tools like Moodle (learning platform) have to be used. Four students estimated that the process benefitted from Wihi, one suspected that it did not make any difference, and one did not have much experience because a greater part of the process was still handled outside Wihi.

Studying the available documentation and observations showed that there were some difficulties with terminology and combining old practices related to the thesis process, and some of these only came out when Wihi was implemented or used. However, based on the Wihi log files, the re-engineered thesis process has been taken into use comprehensively.

5 Discussion and Conclusions

Although the developed tool, Wihi, was rather new to the users at the time the interviews were done, we observed remarkably small amount of change resistance. Some criticism was focused on the features of Wihi, but mainly the changes were welcomed. It was seen that Wihi enables flexible design and follow-up for all thesis parties. In addition, students setting and completing tasks, as well as phase approvals and feedback from the supervisor helps students to motivate in their projects.
It was appreciated that the tool developed for supporting personalized learning not only supports the students' flexibility but also the supervisor' ability to keep track of the situation and to supervise each student individually based on their own plans. In addition, since Wihi is not bound by time or a place, it gives supervisors more flexibility to organize their work. Visibility of the process has also improved: supervisors are able to follow the progression of students, students get comments, feedback, and guidance on time, and program managers and coordinators see what the whole situation is: how many students will graduate and whether there is a need for special arrangements (supporting courses, etc.).

The accumulated data was also considered useful. Both students and supervisors valued the comments, interim versions and other project documentation saved in one place during the project, but the data is valuable in the thesis evaluation phase as well. In addition, if complaints occur, it is easy for external reviewers to evaluate the project. We see that saving all learning process data to one student-specific portal is always important in personalized leaning, and reliable data collected in one place opens interesting possibilities to use machine learning and AI solutions to analyze the data and support and develop the personalized learning further. This is a one of the main topics of future research.

In this study, we found that the developed thesis supervising system, Wihi, helped not only students but also supervisors to get rid of the known challenges of personalized thesis projects by providing necessary process support while remaining flexible. Also, personalized thesis process requires more flexibility on the organizational level, for example, because the starting and ending points of the personalized thesis processes differ from student to student. But, organization also benefits from personalization and from Wihi, for example, by getting current data

on the progress of the individual thesis processes, as well as having visibility to the processes instead of just getting the results afterwards.

The thesis process can be considered as a good example of personalized learning, and the principles applied in digitalizing the thesis process can be applied in other teaching and learning processes. The next research step is to elaborate the applied principles in other teaching processes in order to enable continuous, personalized learning.

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