Assisting Self-study at the University of Twente Through Student Tutors and Digital Solutions

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ABSTRACT

In the recent Covid 19 lockdown period, a lot of educational activities had to shift from face-to-face to digital replacements. As a result, digitalization of teaching has increased exponentially, and most university staff and students have become more familiar with digital tools such as Zoom. At the University of Twente (UT), multiple courses are using student tutors to help assist other students during tutorials. Student tutors are high-performing students who tutor other students in courses they previously passed. Student tutors are valuable because they improve the educational support and quality by helping other students with various questions and problems they encounter during their homework and projects. However, outside of university tutorials there are no student tutors to help assist with self-study at the University of Twente. Especially in difficult courses such as mathematics related subjects, students seem to be struggling with self-study. This paper aims to identify the biggest problems and needs of students at the University of Twente during their self-study through conducting a survey among UT students. Based on the survey results and existing literature on digitalization of learning, a design for a digital tutoring platform aimed at assisting self-study outside of UT classes will be proposed.

Keywords

Distance learning, education, online learning, self-study, student tutors, tools, university

1   INTRODUCTION

In their literature review, Wong and Li [20] mention benefits of smart learning such as teaching and learning support, being positively perceived by students and teachers, and improved learning outcomes. These benefits are achieved through increased learner motivation and interest, the enrichment of learning experiences and the increase of interaction and collaboration.

Elberkawi et al. [5] Discuss the challenges and recommendations in digital learning during the Covid-19 pandemic. The main problems

are social challenges such as students not being able to work in a group. Some students are also not willing and able to connect and work together with students and teachers. Digital tutoring systems can provide an adequate solution for these problems because collaborative online learning and tutoring seem to be solutions that could possibly solve some of these challenges.

Even now that the impact of the pandemic has diminished and face-to-face activities have become more frequent, digital tools are still used as support for several activities, in conjunction or alternative to classroom-based lectures. Thus, blended learning, i.e., a method of teaching which integrates digital tools and traditional face-to-face approaches, is becoming more and more integrated into the curriculum[1]. Dandoy and Mallari [3] put forward some interesting benefits of blended learning and digital learning such as digital collaborative learning, enhanced communication through Facebook groups and immediate teacher feedback.

The sudden shift to digital and remote learning during the Covid-19 pandemic had at least one positive side effect. It has caused teachers and students at the University of Twente to become more familiar with digital tools that may be used as support for teaching and learning, such as video conference tools like Zoom, Teams and BigBlueButton [4].

Interviews of the teaching staff of EEMCS and BMS faculty members at the University of Twente conducted by Dibbets [4] suggests the need for more self-study assistance at the UT. Additionally, Dibbets' paper presents some information on teaching staff preferences that will be considered in the design of the digital tutoring environment, which will be introduced in section 6 of this proposal. Most teachers prefer to use software like Zoom, Teams and BigBlueButton in their classes and 7.7% have experience with Discord in teaching. When it comes to experience with advanced or very new communication software such as Gather.Town, teachers report having little to no experience. Teachers also indicated screensharing, chat and video conferencing functionalities to be very desirable when teaching online. Finally, teachers also pointed out that they would like to see interactive self-study in a digital environment, which this paper will further explore.

This paper aims to provide some relevant insights into the digitalization of education, assistance of self-study through digital tools and online tutoring to assist self-study. From the literature review and the survey among University of Twente students, a good overview of problems and needs of the students during their

self-study is expected, which can be relevant for other researchers in the domain of self-study at universities. By doing further literature review, trends in digital tools, digital teaching and digital learning will be obtained. From these results, a set of requirements can be made. Based on these requirements, an initial design for a digital tutoring platform and tools to assist UT students during self-study will be proposed.

The design for a digital platform to assist students during self-study will be customized to the problems and needs of the UT students. Educational institutions similar to the University of Twente may benefit from the results in this paper and use the proposed solution in their curriculum.

2   PROBLEM STATEMENT

Informally asking 50 other students at the UT shows that for mathematics related courses, students struggle with self-study and want more support outside of university classes.

Furthermore, research has been done in fields such as tutoring and self-study at universities. Some trends on digital learning have also been researched well, especially during the Covid-19 pandemic. However, limited research can be found when combining the terms of tutoring and self-study. Especially in the digitalization and assistance of self-study at universities, more research is needed.

Additionally, almost no research can be found on using student tutors to assist in self-study, especially not in a digital environment. By doing literature searches and conducting a survey among University of Twente students, this paper aims to provide some relevant insights into the topic of digitalization of self-study and how tutoring can help with assisting self-study. By combining the requirements that follow from the survey into the problems and needs of UT students and the literature review, a design for an online self-study assistance platform will be proposed.

2.1   Research question

The problem statement leads to the following main research question:

How can an online self-study assistance platform using digital tools and services be designed to cater to the particular problems and needs of University of Twente students?

This main research question will be answered by the following sub research questions:

- **SUB RQ1:** What are the trends in how digital tools and services can supplement self-study challenges through online tutoring or other methods?
- **SUB RQ2:** What are the current problems and needs of students during self-study at the University of Twente?
- **SUB RQ3:** How can tutoring combined with digital tools best be facilitated at the UT to assist the self-study process of students?

3   METHODOLOGY

This research is composed of three distinct phases, each one aimed at responding to one of the research questions. In this section, a short description of these phases is made.

First, a literature search has been done to familiarize with trends in self-study strategies, learning and teaching techniques as well as digital tools students use when self-studying. Problems and challenges students are experiencing during self-study have been analyzed. Furthermore, literature search techniques and Google

searches were done to identify trends in learning strategies, tools and digital platforms that are relevant for assisting self-study.

Additionally, conference proceedings of the International Conference on Educational and Information Technology were scanned to gather interesting papers on digitalization of education. Next to that, the literature search has been done through Scopus using the following keywords in various query combinations:

Keywords: self-study, strategy, problems, education, university, remote learning, digital tools, applications

To get a bigger amount of quality papers in the query, synonyms and similar phrases like the keywords above have also been used in various combinations. For example, 'self study' could be replaced by 'individual study' and 'digital' could be replaced by 'online'. Drilled down sources from citations and references were also explored.

Examples of some of the Scopus queries that have been used and further adapted can be found below:

(TITLE-ABS-KEY (problem* OR struggle* OR issue* OR challenge* OR obstacle*) AND TITLE-ABS-KEY (education) AND TITLE-ABS-KEY (self-study))

(TITLE-ABS-KEY (self-study OR "self learning" OR "individual study") AND TITLE-ABS-KEY (university) AND TITLE-ABS-KEY (digital OR online OR remote) AND TITLE-ABS-KEY (tool* OR method* OR system*) AND TITLE-ABS-KEY (education*))

TITLE-ABS-KEY ("student tutor" AND universit* AND education)

Secondly, a survey was conducted among UT students. The goal of the survey is to gather the problems that students at the UT have during self-study and find out what student's needs are when it comes to assistance of self-study. The survey is targeted at students at the University of Twente. To maximize the diversity of the demographics, students were approached in various locations. Students were approached at UT buildings on busy junctions, inside various UT buildings near busy areas such as entrances and locations where students relax during breaks. Some buildings included were the Vrijhof Library, Horst, Bastille and Waaier.

The interviewer stood at the location and approached the first student in sight to avoid bias from selection. Participants were asked to fill in the survey on their phone. The surveys were spread out over at least 2 days and multiple times to limit bias. To get relevant results, at least 100 surveys were conducted.

Finally, based on the results from the survey and the literature review, a design for a self-study assistance platform using online student tutors and digital tools will be proposed. The design will include a list of requirements and screenshots of the mockup environment.

4   LITERATURE REVIEW

In this section, trends in digital learning will be explored first. Secondly, learning methodologies will be discussed, followed by a summary of self-study problems. Furthermore, digital tools and tutoring will be discussed. At the end of this section, the barriers in digitalization will be introduced.

4.1   Digital learning

The shift to smart learning comes with many benefits. The literature review by Wong and Li from 2021 covers 155 articles related to smart learning and discusses various benefits of smart

learning [20]. In figure 1 in appendix A, the visualisation of these benefits can be found. Most benefits are in the categories of teaching and learning support, positive perceptions and improved learning outcomes.

Some interesting benefits regarding teaching and learning support are enrichment of learning experiences (e.g. virtual labs), support for teaching and learning diagnosis (such as analytics to identify problems), ubiquitous and self-directed learning (e.g. auto-generated reflective reports), digital and timely feedback, real time scaffolding of students and intelligent classroom management.

Benefits in the category positive perceptions are the following: enhancement of learning interests and motivation (such as a web based smart learning system with chat and notes functions which allow students and teachers to interact), ease of use and acceptance, higher learning engagement (for example through gamification) higher learning satisfaction and increase of self-efficacy and confidence.

The improvement of learning outcomes can be linked mostly to increase in interaction and collaboration such as the flipped instructional model. Improved academic performance is also reported often. Finally, smart learning can improve skills and competences of students.

In their 2020 literature review of 85 papers in the field of 'smart learning' which is closely related to this paper's main topic, Wong and Li present the following results. The most frequently used features are collaborative learning (24%) and personalized content (22%). Some moderately frequent practices include adaptivity, context-awareness, facilitation of interaction and intelligent recommendation. Some less frequent features are real-time responses, learning which was ubiquitous, experience -based and self-regulated and the provision of rich learning resources.

The work of Maatuk et al. [10] further highlights benefits of e-learning according to students and teachers: e-learning is useful, helps students to be safe and improves their academic standards.

The article by Barbashina [2] highlights advantages such as being able to get trained on the job without being separated from family or job obligations. Another advantage is being able to study everywhere, anytime.

Research by Wang [16] confirms that MOOCs (Massive Online Open Courses) are used frequently by students (30%). Furthermore, due to technological advances and the big data revolution, data collection, monitoring and early warning processes have become possible. Data collection and analytics can be used to collect learning behavior, learning investment and obtain feedback and teacher evaluation.

In 2010, Hung et al. proposed the OLRS: online learning readiness scale, which measures learner's readiness for online learning [7]. The OLRS spans across the following dimensions: computer/internet self-efficacy, self-directed learning, learner control, motivation for learning and online communication self-efficacy. In their study, students obtained significantly lower mean scores for self-directed learning and learner control.

According to empirical research by Wang et al. [17] student's preference to online learning is high. It satisfies the needs of students to complete learning tasks and to acquire information. Additionally, they found online learning can meet the social needs of students. Students report high information literacy in awareness,

knowledge, ability, and ethics, which indicates they possess the right skills for online learning.

The systematic literature review by Talha and Rami [15] highlights important factors for successful online learning that have also been mentioned by previous studies in this paper. These include the sharing of ideas between peers, student satisfaction, students' literacy, self-regulatory learning behavior contributing to learner autonomy, instructor feedback, catering to differences in learning style, self-motivation, more interaction, different instructor facilitation strategies, system and information quality as well as organizational readiness. Their main priorities for reorienting organizations to online distance learning are "providing educational content to all students, developing more partnerships with community, developing self-study skills, shifting students from passive to active learning, reconsidering e-assessment mechanisms, and providing support for faculty members." Support for faculty members could be realized by providing administrative support, personnel support including pedagogical support and technological support.

[21] Yoo and Jun mention learning satisfaction and learning achievement as two outcomes of distance learning. Learning satisfaction is important because it correlates significantly with learning achievement. The two main factors in nursing distance learning that affect learning satisfaction are teaching presence and self-regulated learning. Other factors are learner participation, self-efficacy, and interaction.

4.2   Learning methodologies

According to Wang's research, "The learning of college students is based on individual characteristics and personal metacognition, motivation, learning interest, learning strategies and self-monitoring can affect the effectiveness of learning to a certain extent."[16] Furthermore, the role of teachers becomes more diverse. Teachers organize, guide, promote, support, provide information and give feedback. Teacher behavior should promote active learning, positive interaction, increase collaboration, assist in self-management, and provide emotional support. They also mention mixed online and offline activities in the form of flipped classroom as the ideal learning environment and suggest using tutors to assist students in academic planning.

In the literature review of Talha and Rami, one of the mentioned priorities for integrating online distance learning in higher education is blended learning [15]. Dandoy and Mallari's work shows blended learning can have a positive effect on learning in distance education while teaching Newton's laws of motion [3]. Blended learning is a form of learning that mixes different pedagogies with technologies from the 21st century. Students liked the blended learning approach and reported better communication with peers and teachers as well as having learned a lot. Important relevant takeaways are the accessibility to online content, enhanced discussions through Facebook group, collaborative sessions through Facebook room and immediate teacher feedback. Processes such as collaborative online sessions, Facebook groups and other features they mention may also prove useful to integrate in the design of a platform to assist in self-study.

Bai et al.[1] report advantages of blended learning such as reduced dropout rates, higher test scores, support of deep and meaningful learning, flexibility, learning efficiency and enthusiasm. They looked specifically into students' autonomous learning behavior in blended learning. Out of the factors they researched, academic self-

efficacy of college students comes out as the biggest impactor of autonomous learning behavior, followed by learning motivation. Learning anxiety indirectly influences autonomous learning behavior through its effect on learner motivation.

Research by Sannathimmappa et al. [13] shows that online synchronous team-based-learning pedagogy is more effective than self-study only control groups and that online team-based learning had equal potential to foster students' motivation, engagement, and knowledge acquisition.

Furthermore, a study by Yu et al. [22] suggests that students' interaction and emotional engagement have significant influence on learning persistence, which is considered an essential factor of online learning. Additionally, emotional engagement also mediated student instructor interaction, student-content interaction and learning persistence. They recommend that interactions between peers and between students and instructors should be promoted. Emotional engagement can be promoted by formation of friendly groups where students feel trusted as well as by providing enjoyable learning activities.

Feng et al. suggest to layer teaching, due to middle performance students scoring lower on preferences towards a smart learning environment than their higher/lower performing peers [6]. Therefore, they suggest educators provide middle performance students with extra strategies and guidance to engage and enjoy learning more.

4.3   Self-study challenges
In the literature review of 155 articles by Wong and Li [20], various challenges to smart learning are identified. In figure 2 the challenges to smart learning that are addressed in the articles are shown, while the remaining challenges are listed in figure 3. Most of the reported challenges are technical problems such as automated classroom management, identification of learning styles and status. As technology develops, technical problems will be gradually resolved, and more innovative solutions are being developed more often. Many of the remaining challenges are not related to technological issues. Integration of technology in the curriculum and instruction are partially addressed but remain challenges. Another challenge is the integration between technology and pedagogy, which is related to the competence and training of teachers.

Maatuk et al. [10] mention several challenges reported in a survey among students and IT faculty members of the University of Benghazi. One of the challenges is that while the workload of teaching staff is decreased, the workload of students is increased. Another issue is the high cost of e-learning. However, these findings are limited to only one university survey.
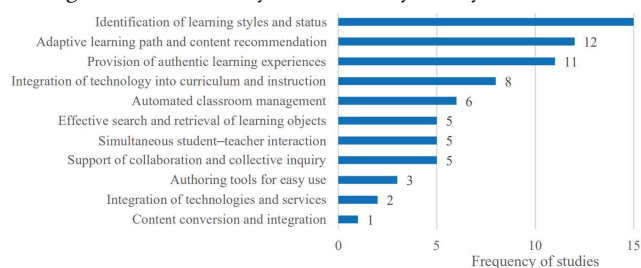
Figure 2. Challenges to smart learning addressed in the reviewed studies [20]
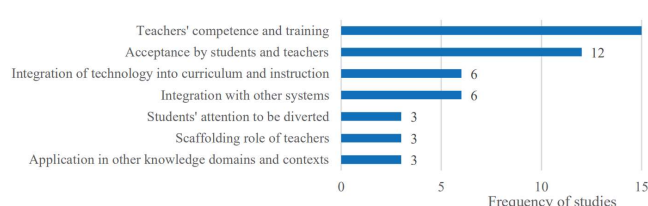
Figure 3. Remaining challenges to smart learning reported in the reviewed studies [20]

Research by Wang [16] highlights multiple issues and challenges with learning in the environment of IT. First, next to online learning, students are spending their online time often on chatting, searching, music, video, and games. Distractibility of students during online learning is therefore a common risk. Furthermore, only 36% of students possess the ability to quickly screen information and 85% of students think that online information is too mixed. Therefore, information literacy of students needs to be improved.

Empirical research by Wang et al. [17] mentions that online learning cannot relieve student's psychological pressure enough. Therefore, guidance should be available. Additionally, they reported significant differences between student's uses and gratifications for different levels of information literacy. The higher the information literacy, the better the online interaction that students will experience. Improving interaction with peers and teachers is an effective way to improve quality of education and learner's uses and gratifications, so information literacy should be improved whenever possible. It is also concluded that individual learning styles and needs differ. Therefore, using big data and similar technologies is recommended, as well as adding dynamic features customized to individual learning needs.

Klimova et al. [8] research further into four concepts that self-regulation is comprised of according to existing research. These concepts/strategies are motivation, competence, metacognitive strategies, and meaningfulness of learning. Based on their survey among Czech and Slovak students they come with a set of recommendations to develop and maintain self-regulated online learning. They recommend timely student assistance, providing guidance, help students link new experiences to prior knowledge, provide corrective and timely feedback by focusing on the task of learning, give students communication options so they can share expertise but also their emotions, promoting student's reflection (e.g., through diaries), adjust assessment criteria to the new environment and stimulate students to self-assess and teachers to use the digital tools frequently.

Challenges with online education in Russia that remain practically unsolved according to Barbashina [2] are the following: functions of students and teacher differ significantly between online and traditional education, lack of online content, student and teacher readiness for online education, lack of defined methodologies and educational frameworks, low psychological readiness of students and trainers, lack of support such as tutors, methodologists and consultants, legal underdevelopment of copyright which results in teachers keeping their methodologies for themselves and lack of high leadership support for IT. They also mention a survey of Russian university students which points to the following main issues: adaptation to training, lack of student-teacher contact as well as lack of student-to-student contact and low communication richness such as nonverbal communication like not being able to

read facial expressions in a chat. Respondents point to student tutors as a solution and claim it can help reduce organizational, educational, and even personal problems. Next to that the organization of the educational process must be improved, for example through manuals on regulations and methodologies.

Elberkawi et al. [5] Discuss the challenges and recommendations in digital learning during the Covid-19 pandemic at a Libyan university. The main problems that are relevant according to this paper are social challenges, such as students not being able to work in a group. Some students are also not willing and able to connect and work together with students and teachers. Personalization of the digital platform and different options to connect with peers and tutors should thus be offered, to cater to individual student's needs.

According to a systematic literature review by Talha and Rami [15] challenges to online distance learning are the following: isolation, limited interaction, technological limitations, catering for an effective learning environment, distractibility, lack of motivation, low digital fluency, and problems with online assessment.

4.4　　Tools that assist in self-study
According to the literature review of Wong and Li [19], the most frequently used tools in smart learning are smartphone and tablet computer/smart pad. Closely followed up in decreasing order of frequency by interactive whiteboard, mobile device/smart device, projector/LCD screen, camera/webcam, sensor, mic/headset, and laptop computer. Augmented reality and desktop computer are least used. They also mention there should be more research done into the institutional support needed for teachers and learners regarding the integration of the tools into the learning environment.

According to Wiyono et al. [18] tools that are most frequently used by lecturers at the State University of Malang in online learning are the following: WhatsApp, Email, Google Meet, SIPEJAR – assignment, Google Classroom, Zoom, SIPEJAR – chat, Quizizz, Google Form, and Youtube.

Dandoy and Mallari [3] mention interesting tools such as Facebook discussion groups, Facebook room for joint sessions and interactive simulation of physics problems through Facebook room. The main advantages are collaboration and enhanced communication, both in teacher-student as student-to-student communication. Since these two advantages keep showing up in most research of online learning, these are vital requirements for the online self-study assistance platform.

In the work of Barbashina [2] various tools are discussed that improve and maximize the communication between students and student-teacher communication. Students communicate informally through social networks and phone chats. Communication between students and their teachers is conducted through e-mail, skype and phone. To minimize communication deficits, student meetings are held. To keep a profound understanding of the educational processes and regulations, manuals are developed and available in the Modular Object-Oriented Dynamic Learning Environment (MOODLE). Course curators and dean's office employees actively communicate with students through phone or email to resolve problems with the educational process when needed.

The article by Neumann et al. [11] presents an innovative tool to scale mentoring of self-study processes: chatbots. The chatbots are in early development but show promising results with features such as automated Q&A, assistance prior to reading and feedback

after reading. The biggest advantage is that chatbots are an easy way to scale mentoring, which can save time and money.

Another example of how chatbots can contribute to the tutoring process is given by Lee et al. [9]. Integrated in Telegram or Facebook Messenger, the chatbot takes away a lot of repetitive tasks from teachers and tutors. These include answering Q&A's, answering on common questions related to course materials and answering logistical questions. By using a login system, the answers can be personalized to different student profiles. Another useful feature is the ability to perform self-tests through the bot's quiz function, which can help in preparing for tests and to find knowledge gaps. In the preliminary evaluation, most students think the bot can effectively act as an online tutor.

In 2021, Dibbets proposed a design for an interactive online medium for team-based learning at the University of Twente, which could also be used for self-study [4]. However, because the focus was not on self-study but on collaborative learning, the Gather.Town environment does not appear ideal for self-study when mapped to the issues found in the literature research in this paper.

The work by Dibbets does provide some relevant insights into the teachers' views towards online learning at the University of Twente. A vast majority of teachers prefer to use software like Zoom, Teams and BigBlueButton in their classes. Surprisingly, 7.7% of teachers have experience with Discord in teaching. When it comes to experience with more novel communication software such as Gather.Town, teachers lack experience. Teachers also indicated screensharing, chat and video conferencing to be very desirable features when teaching online.

4.5　　Tutoring in assisting self-study
In the work of Barbashina [2] about online education in modern Russia, students point to student tutors as a solution and claim it can help reduce organizational, educational, and even personal problems.

Silén and Uhlin [14] mention the role of the tutor in self-directed learning and problem-based learning approach. "The tutor is supposed to challenge students' critical awareness in their interaction with the people involved, the subject matter and the actual learning environment."

Because of the lack of high-quality research within the scope of the literature review on student tutors in (online distance) education similar to the situation at the UT, the main best practices of student tutoring as well as the tools that the UT uses at the moment of writing this paper will be applied to determine the final integration of tutoring into the online platform.

4.6　　Barriers in digital transformation
Literature review backed by an empirical study conducted by Rima, Ferdiana and Suning [12] shows there are multiple barriers in digital transformation in higher education. Thus, the design of the system should take into account the barriers in the contextual, social, technical and cultural domains shown in figure 4.

Contextual Domain	Social Domain	Technical Domain	Cultural Domain
•Lack a clarity of vision on the digital transformation •Lack of a shared vision •Lack of strategic planning •Translating strategy into a concrete plan of action •Lack of human resources or expertise in digital transformation •Insufficient funds •Lack of time •Lack of institutional policy •Lack government vision, plan and policy •Uncertain economic environment to promoting integrating of ICT in its core business process	•Lack of leadership behaviour •Lack of organizational leadership skills to ideate, plan and lead execution •Insufficient Digital Technology Skills	•Weak and unsupportive IT infrastructure •Embedding ICT into educational systems •Lack of IT support service •IT risk	•Difficulties to keep up with technological changes •Lack interest in technology and innovation •Reluctant to leave their comfort zone •Attitudes and beliefs about digital technology •Lack of commitment

Figure 4. Barrier framework by Rima, Ferdiana and Suning [12]

5   SURVEY INTO THE PROBLEMS AND NEEDS OF UT STUDENTS DURING SELF-STUDY

In this section, the survey goal, methodology and results will be discussed. The visualizations of the multiple-choice questions can be found in appendix B.

5.1   Survey goal

The main goal of the survey is to formulate an answer to research question 2: what are the problems and needs of UT students during self-study?

5.2   Method

The study was conducted during 2 weekdays in June 2022. Students were approached near entrances of buildings at the University of Twente. Students in buildings including Ravelijn, UT library, Technohal, Horst, Bastille and Carré were asked to fill in the survey. The supervisor approved the methodology and ethically sound principles were used to conduct the survey. Participants were informed about their data collection and processing. The faculty standard tool for conducting surveys, Qualtrics was used to ensure secure data collection and storage compliant with modern standards such as GDPR. Only complete responses of University of Twente students were used for the results, amounting to 121 valid responses. The survey leaned slightly towards male respondents with 74 males, 42 females 1 non-binary/third gender and 4 'prefer not to say'. Sixty-four percent of the respondents were in the Bachelor phase of their studies, while 36% were in a Master. This study leaned significantly towards first year point-of-view, as they were over-represented with 42%. Second, third- and fourth-year students were represented by roughly 15% each and 5th and 6th year students were underrepresented with about 6% per year. Responses were relatively diverse as students were spread across 22 different studies. Mechanical Engineering (14%) and Applied Physics (10%) were most represented which should be considered when judging the generalizability to other studies. Other represented studies were Biomedical Engineering (6%), Industrial Engineering and Management (5%), Technical Medicine, International Business Administration, Technical Computer Science (all 4%), Electrical Engineering, Creative Technology, Industrial Design Engineering, Advanced technology, Chemical Science and Engineering (all 3%). To keep this paper short, studies that were represented by 2% or less such as Communication Science and Psychology are not mentioned.

5.3   Results

Open question 1: What are the top 3 subjects in your study where you struggle with self-study the most?

For this question, the most common answers were grouped into relevant categories and counted by hand. Only categories that were issues *across* different studies were considered. From this question, the top 2 problem categories were identified. Over 40% of students mentioned a math-related subject, indicating that students struggle with mathematics a lot. The second biggest category was that of research/thesis/literature/writing of reports, which was mentioned by 25% of the students. Most of the problems lie in the thesis and writing skills, while some students also mention problems with reading related capabilities.

Open question 2: Imagine you are doing self-study: what are the biggest 3 problems you are experiencing?

Students mentioned many different problems. The most often mentioned problems were motivation, distraction/focus, procrastination, time management and boredom. Motivational issues were most frequently reported. Some other problems that were mentioned relatively frequently include support from other students or teachers, as well as not having enough practice exercises.

Open question 3: What solutions do you currently use to assist you in your self-study process?

Studying together was mentioned very frequently, while going to a quiet study environment such as the library ranked second. Students also mention they limit distractions, for example by using noise-cancelling headphones. Next to studying collaboratively, another common way to increase motivation is by rewarding oneself after studying. This can be in many forms, such as a nice break where the student can do anything, socialize with peers, or eat a cookie. Furthermore, students report that taking small breaks helps them to improve focus. Finally, students also mention more helpful solutions such as asking questions, using tools for time management, improving motivation, limiting distractibility of smartphones by switching them off, better time management, using internet material such as online tutorials and drinking stimulants such as coffee.

Open question 4: What digital tools / solutions do you currently use to help you with your self-studies?

One of the most frequently reported tools is the focus tool called Forest. In this app, students plant a virtual tree when they start focusing. When they stop early, the tree is killed, which keeps students on focus. Additionally, Pomodoro timers are used often. Students also mentioned that they listen to music frequently to help themselves stay focused or to relax. Furthermore, students mentioned time management and planning tools such as calendars. Communication tools such as Discord, MS Teams and WhatsApp are also popular. Google and YouTube are also very frequently reported as they help with tutorials and finding answers to questions.

Open question 5: What self-study support, solutions or tools are still missing at the University of Twente?

Students mentioned that they would like to see more and higher quality study spaces and project rooms. Furthermore, students would like to have higher quality and availability of practice material such as online micro lectures and in-depth answer sheets.

Finally, students frequently mention a desire to be able to ask questions to student tutors or teachers on an online platform.

Open question 6: What would motivate you to use an online platform where you can optionally self-study collaboratively with peers, get tutor and teacher feedback or get helped live by tutors?

Most students said they would be motivated to use the platform if it even *existed*. Furthermore, many students said they would use it if many of their fellow students also used the platform. When students are studying with fellow students, there is a certain 'social pressure' which helps with studying more, better, and not getting distracted. Besides, there are more advantages of learning together, which have mostly been covered by the literature review. Rewarding students for being on the platform was also frequently suggested. This could be in a small exam grade increase for using the platform, or by students getting higher grades due to their better study efficiency. Also, the availability of good quality tutors or teachers was mentioned as an important motivational factor. Ideally, there would always be tutors available, resulting in minimal time between a question being posted and being resolved. Finally, ease of use and a good user experience are also mentioned as important factors.

Open question 7: At what time blocks do you frequently self-study?

Students reported varied study times. Most students mentioned they study from nine to five. Evenings were also frequently reported. This is interesting, because in the evening there is not much support for students available at the UT.

Multiple choice question 1: Would you like the option to be digitally tutored through e.g. MS Teams outside of University classes during self-study if it was provided by the UT for free? (Similar to Teaching assistants at the UT.)

This question ranged on a 5-point LIKERT scale from 'dislike a great deal' to 'like a great deal'. The majority of respondents (64%) reported between like somewhat or like a great deal, indicating that students believe this solution can help them.

Multiple-choice question 2: On average, I would use this digital tutoring system mentioned above

This question is distributed on a LIKERT scale ranging from never, once per week, one to five times per week to more than ten times per week. Out of all participants, 82% claimed they would use the tutoring system at least more than once per week, which indicates incredible interest from the students. Forty percent of the students said they would use the system between 1 and 5 times per week, while only 18% of students indicated they would never use the system.

Multiple choice question 3: I would like the option to do self-study together with students from my course through a video call platform like Discord, Teams or Google Meet?

This question ranged on a 5-point LIKERT scale from 'dislike a great deal' to 'like a great deal'. Roughly 57% of students indicated they at least liked it somewhat, or liked it a great deal, which indicates high interest between students. Less than 20% of the students had a negative view towards this feature, while the remaining 80% was neutral or positive.

Multiple choice question 4: I would use the option to do self-study together with students from your course at a distance through a video call platform like Discord, Teams, Google Meet?

This question is distributed on a LIKERT scale ranging from never, once per week, one to five times per week to more than ten times per week. A large majority of 78% of the students claimed they would use the platform at least once per week, while 41% indicated they would use the platform between one and five times per week. These numbers show a positive interest from the students towards collaborative online learning during self-study.

6   DIGITAL PLATFORM DESIGN
In this section, the design for a platform to assist self-study at the University of Twente through student tutors and digital tools is proposed. The chosen platform is Discord. Discord is an online communication platform that can be customized significantly. It offers the possibility to create a server, in which one can make categories and communication channels such as chat or video call channels. Furthermore, students and teachers can get customized roles and different permissions based on these roles. Next to that, Discord allows custom 'bots' (custom programmed software) to be integrated with the server, which allows for custom features to be developed and integrated relatively easily.

6.1   Mockup platform choice
Discord is chosen as the main platform because teachers and students at the UT have experience with it already, which will make adoption significantly easier. Furthermore, it provides the opportunity to cater to most of the issues raised by the student survey and the literature. Additionally, Discord is not expensive and can be customized to a great extent. Furthermore, Discord allows programmers to make custom changes and additions to their Discord server using Discord bots, which allows for custom solutions such as a radio channel that plays user's favorite music. Discord bots are pieces of software that can be custom made that can change almost any part of the Discord experience. This allows for easy addition of features when necessary. However, this does not mean that the prosed design could not be implemented in different platforms using software like Slack or MS Teams. A screenshot of the mockup design can be found in appendix C. In the following section, the mockup design will be discussed.

6.2   Main functionality
One of the most vital functionalities of the platform are the channels where students can study collaboratively online. Both the student survey and the literature show the need for and advantages of collaborative learning. A simple way to set this up is to have multiple regular voice channels in the Discord study server named *'study-session#x'* where students can go to whenever they want to study together online. Additionally, there could be a chat channel where students can schedule physical study sessions together.

Another very important feature that came up in the literature review and survey is feedback. Students should be able to get high-quality and timely feedback from their peers, tutors and teachers. For different needs, there must be multiple channels with different purposes. For smaller and easier questions that do not need immediate feedback, a text channel shared with all students, student tutors and the teacher can be used. The ideal case would be that students help each other. When necessary, student tutors or teachers can step in to moderate, guide or help. Moreover, a common questions section should be made, so that frequently asked questions are not constantly keeping tutors and teachers busy. This section can also be reused in the upcoming years to save time of tutors and teachers, which can save the faculty some money.

Another benefit of Discord is that students can use the search question to find previously asked questions quickly.

For the more complex student questions and problems, student tutors should be ready to help. In the survey presented in this paper, students have shown high interest in the possibility of student tutors that are instantly available online, whenever they are needed. This may impact the number of tutors hired for each module and moreover, affect the way the tasks are commonly distributed to tutors by the module coordinator. Thus, discussions with the module coordinator and the bachelor program directors are needed to understand if this is a realistic option. An alternative is to have tutors indicate their available times in a common area that all students can access, such as the welcome channel, which presents general information about the configured Discord server. Furthermore, research needs to be done to confirm the exact amount of time students will use it, because a student saying he will use the system is not the same as the student making use of it. Based on the information of the survey, it is proposed that for large courses of over 100 students, there will be at least one tutor between 10am-10pm. In a class of 400 students, this would amount to an estimation of 9 euro per month per student in costs. When more research is done into peak hours, the amount of assigned student tutors per hour can be changed accordingly. Analytics into the peak times can easily be collected by making use of existing or custom Discord bots that measure usage statistics.

For the tutor queue, it is suggested that during busy times, the Horus software of the UT is used. Horus is a virtual queueing website that mimics students raising their hand to ask a question. Advantages of Horus are that students can see which position they are in the queue and that students get notified when their question is accepted by a tutor. A custom link to the specific Horus room should be put in the chat channel of the Discord server, while the helping of students can be done in the voice channels of the Discord server. If preferred, the Horus queue could also be replaced by a custom Discord bot that mimics a queueing system.

6.3 Additional functionalities through Discord bots

A bot could be made for the purpose of reducing the time of teachers and students. For example, when students ask a question in the question chat, a bot checks whether a similar question has been answered before and notifies the student. If the answer in previous questions or common questions is sufficient, the bot can set the question to resolved.

To motivate students to study together more often and use specific features of the platform such as answering each other's questions, custom bots can be developed. For example, users could have ranks from *level 1 helper* to *level 10 hero* and progress by earning points for answering each other's questions sufficiently or by spending time in the collaborative study sessions. The mere presence of ranks and levels as a form of recognition may motivate students to study better and be more collaborative. However, to further stimulate students, a small increase in grade as a reward for helping each other and being active is suggested.

Discord bots with analytical tools can be implemented or custom made to measure the activity and performance of students, which can be used by the teachers in various ways. For example, teachers could use analytics to find out how 'test-ready' students are, or if students that studied longer pass the exam more often than their peers.

The expansion of adding other functionalities through Discord bots is endless. More Discord bots that could be used are the following: Discord bots to help with staying focused, such as pomodoro timers and an integration with the Forest app could be made. Pomodoro timers are a small 25-minute focus window followed by 5-minute breaks, to space studying. In the Forest app, users grow trees that stop growing when they get distracted, which motivates users to stay focused. The Forest app allows users to make groups to compare performance. A link to the shared Forest group can be put in a Discord channel to stimulate students to improve their focus. From the literature review and the survey, more suggestions are bots for study music, planning assistance, deadline control, automated testing and more.

6.4 Barriers

Because the chosen platform is relatively known among UT students and teachers, no major adoption issues are expected. However, teachers should have access to enough methodological guidance to adapt their courses to the model of online assisted learning support. Furthermore, students and teachers should have adequate IT support and manuals should be readily available.

7 LIMITATIONS

The survey had only 120 participants and included only students that were present at the UT physically. The generalizability to other non-technical universities is therefore limited due to the heavy focus on the student's point of view and the fact that the main studies represented in the survey were technical. Furthermore, the functionality of the basic Discord server does not include all desired features such as recording, but this can easily be added using external tools or a custom Discord bot. Finally, the performance of the proposed design has not been tested during a live course, which is something for future work.

8 CONCLUSION

This paper has introduced a design for an online platform to assist in self-study at the University of Twente, using digital tools and online tutoring.

This paper has some limitations, including limited generalizability to other (less technical) universities and the fact that the default functionality of the chosen platform is not 100% complete. However, those limitations can be overcome by conducting more research and by developing new or implementing existing custom Discord bots for the small amount of missing functionality.

First, the challenges in online learning and self-study were identified by reviewing the existing literature. Trends in the digitalization of learning, (online) learning methodologies, tools, services, and tutoring have been discussed.

Secondly, a survey among 121 students at the University of Twente was conducted to identify their problems and needs. The main problems students reported struggling with, could be grouped into two categories: mathematics subjects and research/thesis/literature/writing. The most frequently reported issue among students was motivation. Distraction/focus, procrastination, time management and boredom also frequently showed up. An interesting finding is that a large number of students reported positive perceptions towards collaborative online study sessions and the availability of an online student tutor that could help them with the problems they come across during self-study. Therefore, these features have been implemented in the final platform design.

Finally, an online platform design has been proposed, aimed at assisting self-study at the University of Twente by using digital tools and online tutoring.

9　　FUTURE WORK

Due to the limited scope, this paper only focuses on literature review, conducting a survey and a mockup design with suggestions for Discord bots that could be developed later. Further research needs to be done to measure how the design of the digital platform performs during live courses. This way, the performance of the platform can be measured, along with feedback from the students and teachers to improve it. Secondly, more research into the development and testing of individual bots is suggested. To make the results more generalizable, the survey could be done on a national or international scale and include more teacher feedback.

ACKNOWLEDGMENTS

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A   BENEFITS OF SMART LEARNING

This appendix contains figure 1. Benefits of smart learning by Wong and Li. [20]
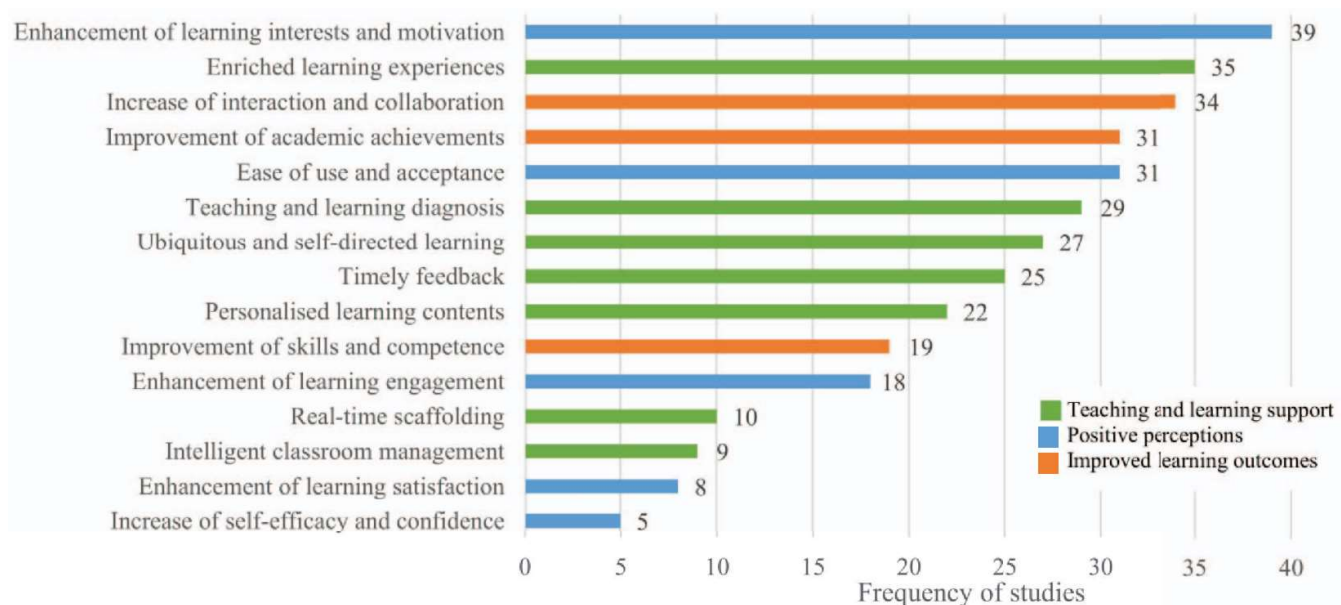

Figure 1. Benefits of smart learning by Wong and Li [20]

B   SURVEY RESULTS

In this appendix, visualizations of the multiple-choice questions of the survey are presented.
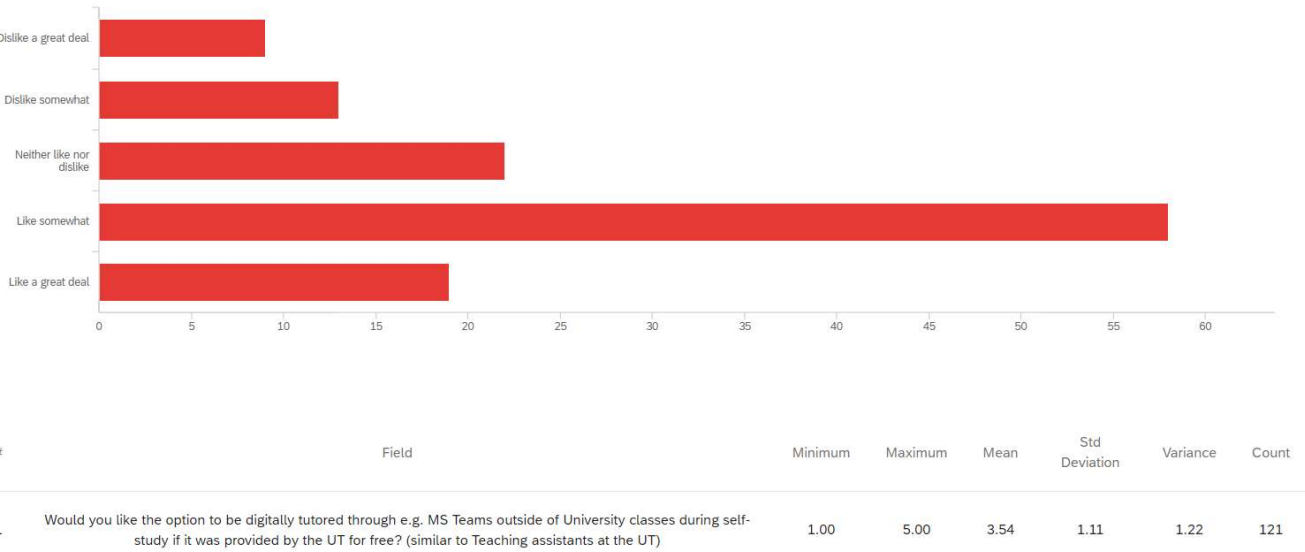

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
	Would you like the option to be digitally tutored through e.g. MS Teams outside of University classes during self-study if it was provided by the UT for free? (similar to Teaching assistants at the UT)	1.00	5.00	3.54	1.11	1.22	121

Figure 5. Multiple choice question 1

12 - On average I would use this digital tutoring system mentioned above   Page Options ⌄

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	On average I would use this digital tutoring system mentioned above	1.00	5.00	2.29	0.82	0.67	121
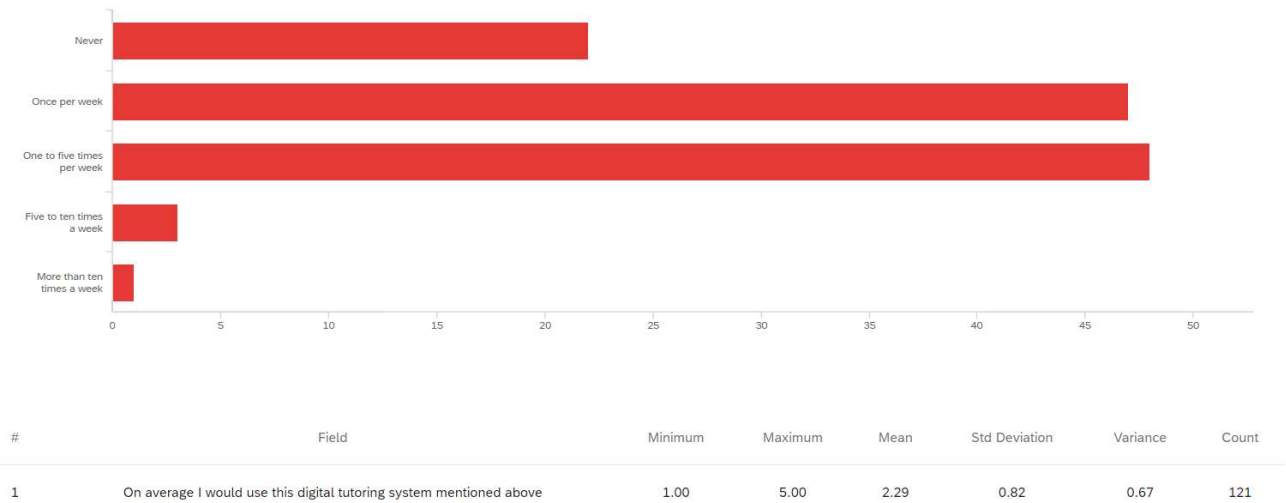
Figure 6. Multiple choice question 2

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	I would like the option to do self-study together with students from my course through a video call platform like Discord, Teams, Google Meet?	1.00	5.00	3.45	1.03	1.06	121

Figure 7. Multiple choice question 3

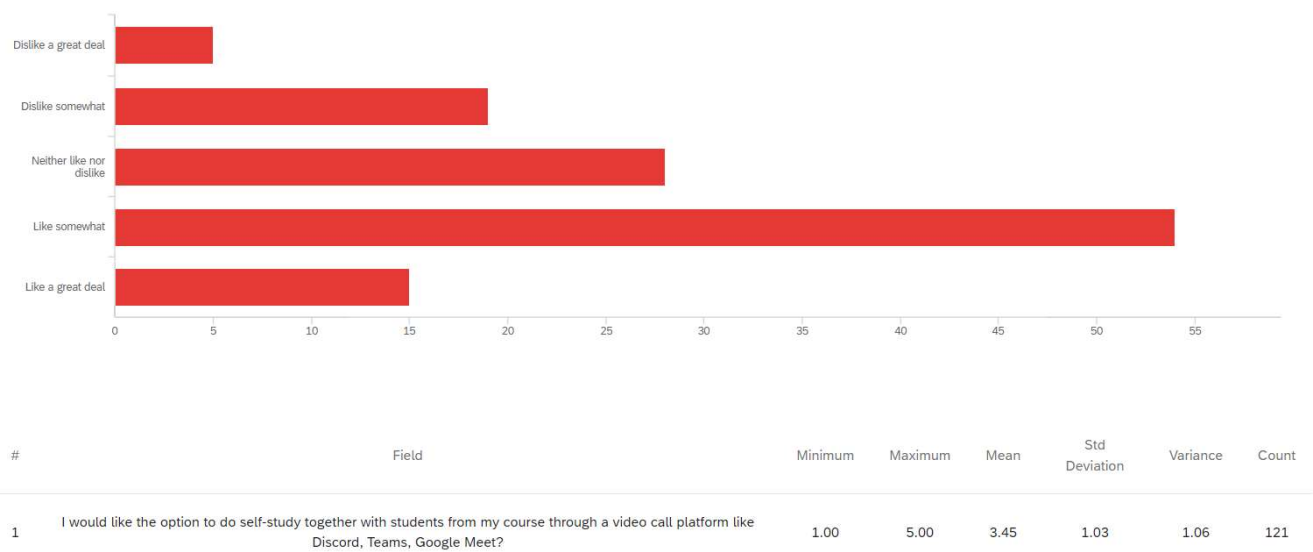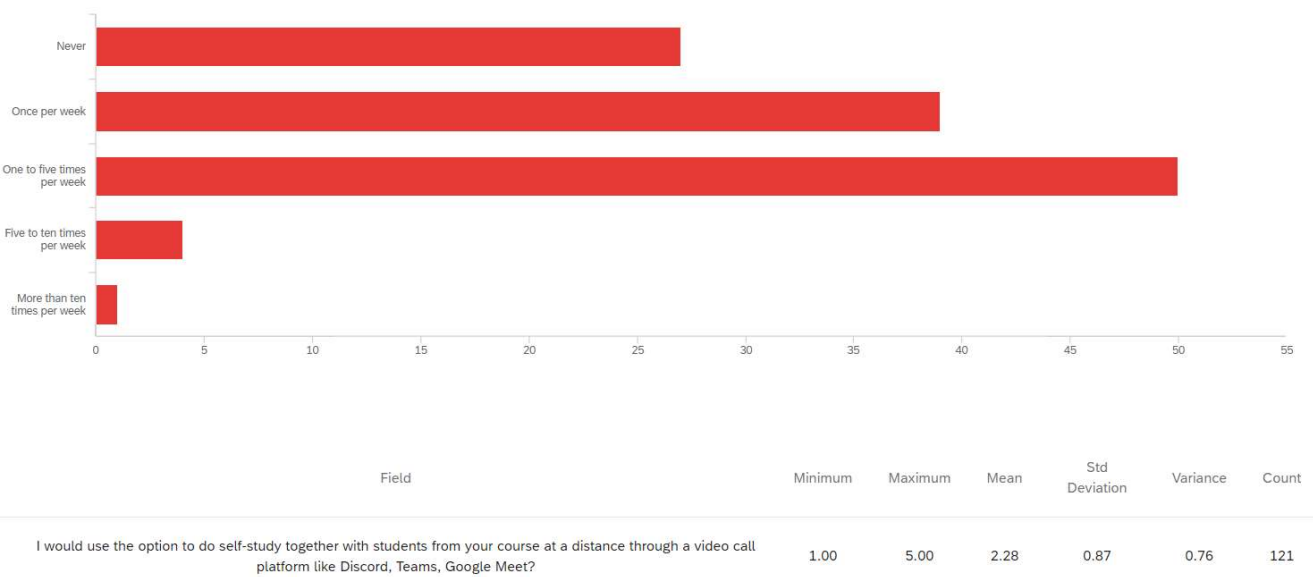| Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
I would use the option to do self-study together with students from your course at a distance through a video call platform like Discord, Teams, Google Meet?	1.00	5.00	2.28	0.87	0.76	121

Figure 8. Multiple choice question 4

C   Digital platform design

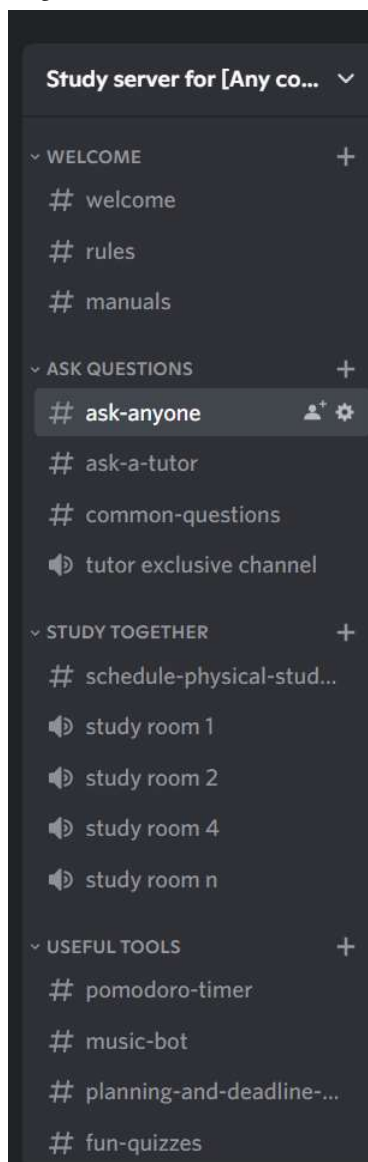Appendix C. This appendix shows a screenshot of the mockup design for the Discord environment.

Figure 9. Screenshot of the Discord server design.