NEW VOCATIONAL SCHOOL STUDENTS' VIEWS AND EXPECTATIONS CONCERNING ONLINE LEARNING AND STUDYING MATHEMATICS

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ABSTRACT
Learning mathematics online in vocational upper secondary education is a growing but little studied area. The main purpose of this research project is to develop an asynchronous online course in mathematics which would be suitable for a variety of vocational fields. This article concerns 824 Finnish students who were commencing their studies leading to a vocational upper secondary qualification in seven different fields and looks at their views on and expectations of the online learning and studying mathematics. The results, which draw on a questionnaire distributed to the students show that they regard online learning as a rather flexible way of studying and that the ability to contact a teacher through chat is considered important when studying in an online learning environment. Compared to some other fields, students of Technology are significantly less likely to think so. According to the results, mathematics is regarded as important for a future career, and it is obvious that students do not want to study mathematics more than their future careers require. The field of study influences significantly a student's experience of the need for support in studying mathematics. Students of Health and Welfare consider mathematics to be as the most important for their future career, but they also feel they are most likely to need support with mathematics.
Keywords: mathematics education, online learning, vocational upper secondary education

INTRODUCTION

The main goal of our research project is to develop an asynchronous online mathematics course which would be applicable to vocational upper secondary students in various fields. The idea is that at least some of the applied tasks in this online course would be related to the student's own field so that the student could demonstrate mathematics proficiency via this online course while completing work assignments that require mathematics during her or his on-the-job training. The general idea is that this online course would be one of the options for completing mathematics studies, so, as a rule, students themselves would choose to participate in an online course. The background to our project is the reform in 2018 of vocational upper secondary education in Finland. Two of the aims of the reform were to increase learning in the workplace and to enhance students' personal learning pathways (National Audit Office of Finland, 2021).

In the development of online studies it is important to get to know the target group at the very beginning. Baldwin and Ching's (2019) Online Course Design Checklist (OCDC) states that students' knowledge base and interests should be analysed before the design of an online course. According to Benigno & Trentin (2000), for example, students' ICT skills and previous experience with online learning can be examined in advance. For this reason, our project commenced with a survey of students' ICT self-assessments and views regarding the importance of ICT skills from the perspective of their future career (Suominen et al., 2021). In this article attention was then paid to what students expect from online learning. Of particular importance were students' attitudes to online learning, including its perceived flexibility and the ways in which it might be provided.

The online mathematics study undergoing development in our project is intended to be completed, at least in part, in the context of on-the-job training. Since some of the mathematics tasks are related to work tasks, it is assumed that the student will complete some of the mathematics assignments with the aid of a device that is always with him or her, in other words, a phone. Another key device for completing online studies is a computer. With the extension of the compulsory education, which came into force in Finland in 2021, the necessary educational materials and equipment will be free of charge for those upper secondary students who are "within the scope of extended compulsory education" (Ministry of Education and Culture, 2021). As a result of the extension of compulsory education, it is expected that more vocational students have been equipped with a (laptop) computer by their educational institutions. From the perspective of developing online learning, it is important that students have the necessary learning tools. In addition, it is important to outline how students view the use of these devices. For this reason, attention was paid to the ways in which students view the use of the phone and the computer in their studies.

One area of interest consists of students' views on interaction with an online teacher or fellow students. New unified assessment criteria have been developed for the common units of the vocational upper secondary qualification in Finland (Finnish National Agency for Education, 2021a). These criteria brought into use in August 2022. One of the topics of the assessment is interaction (Finnish National Agency for Education, 2021b), and the present article provides a certain amount of information about the student's expectations of interaction in online learning. The findings of the part of survey concerning online learning will be used to develop not only aspects of an online course in mathematics but also in relation to teaching other common units of the vocational upper secondary qualification online.

In this article attention will also be paid to how students at the beginning of their vocational education see their own skills in mathematics, whether they perceive mathematics as important for their future career and what they expect from studying mathematics as part of their vocational upper secondary education. It will be important to find out how students view, for example, the idea of studying mathematics either in the workplace or online.

REVIEW OF RELATED LITERATURE

In the course of time, online learning has become increasingly popular. In particular, the COVID-19 pandemic has led to a clear increase in online learning at all levels of education. This has resulted in a growing body of research on what makes online learning successful and satisfying. Student satisfaction is considered to be one of the indicators of the quality of online courses (Quality framework: The student satisfaction pillar, n.d.). In the following sections previous research related to the multidimensional factors affecting success and satisfaction in the context of online learning are reviewed so that they can later help to reflect our own findings concerning upper secondary vocational school students' views and expectations regarding online learning. This theoretical background also deals with aspects related to the process of studying of mathematics, such as students' attitudes and their mathematical self-efficacy.

Use of Smartphones and Computers in Studies

In our investigation the students' willingness to use a phone and a computer (whether a computer means a desktop computer or a laptop computer, was not specified in our questionnaire) in their studies were examined. E-learning material delivered via mobile devices such as mobile phones or tablet PCs can be defined as mobile learning (m-learning) (Ally, 2005). Göksu & Atici (2013) mention a laptop, tablet PC, personal digital assistant and smartphone as devices for mobile learning. Students use mobile devices in their everyday lives and the use of the smartphone, for example, is also popular for study purposes. In vocational education, mobile devices are used, for example, to support learning with supplementary exercises (Ricky & Rechell, 2015).

Yan et al. (2021) studied K-12 students' (N = 1 048 575) experience of online learning during the COVID-19 pandemic. They noticed that the majority of students used smartphones in their online learning, while only a quarter of the students used a computer. In turn, in Sungjeminla's (2022) study 91.83% of 159 undergraduate college students used smart phones for online classes. In their review article Sung et al. (2016) observed that 69.95% of learners using mobile devices achieved relatively better results than did the minority not using mobile devices with regard to the dependent variables associated with cognitive achievement. Gómez-García et al. (2020) noticed that in education centres where smartphones were used for educational purposes, students achieved better academic results. It has also been observed that mobile learning technology can increase students' conceptual understanding of some mathematical functions (Sincuba & John, 2017). Students' attitudes connected to the use of mobile devices in learning have been studied to some extent. For instance, Sincuba & John (2017) and Yang (2012) have noticed that students displayed positive attitudes to mobile learning. Students found that mobile learning offered them more opportunities to get more information and it also underpinned collaborative and pervasive learning (Yang, 2012).

In turn, students' computer use has also been studied previously, for example from the perspective of accepting online learning (or e-learning. To check out our discussion of the terms *online learning*, *e-learning*, *distance learning*, and *virtual learning*, please see Suominen et al., 2021). Previous studies have found that the *acceptance* of students' e-learning is influenced, for example, by their individual previous experience of personal computers (Selim, 2007), by their confidence or knowledge of computer use (Keller et al., 2007) and by their computer self-efficacy (Kang & Shing, 2015). Concomitantly, students' *satisfaction* with e-learning is influenced, for example, by their knowledge of the various Internet technologies (Yalman et al., 2007) and by their level of computer-anxiety (Sun et al., 2008). Hence, in our first article vocational students' basic ICT skills self-assessments were examined (Suominen et al., 2021).

Attitudes to Online Learning

When teaching is transferred online, finding out students' attitudes and expectations helps in the creation of online learning that is suitable for the students. As mentioned above, previous studies have examined the impact of students' previous knowledge of computer and Internet technologies on the extent to which they accept and are satisfied with online learning. This section also reviews the influence of other factors studied, such as gender, age and residential area, on attitudes towards online learning. Rhema & Miliszewska analysed (2014) the attitudes to e-learning expressed by 348 undergraduate engineering students at two Libyan universities. The study showed that students' attitudes to e-learning were mainly positive and there were no significant differences between the genders or the students' locations (urban/rural). For their part, Peytcheva-Forsyth et al. (2018) observed the attitudes and perspectives to online learning held by 590 undergraduate students at a Bulgarian university. The researchers noticed, for example, that age will have an impact on whether a student returns his or her homework online rather than in person: among 18–21-year-olds, 61.2% of respondents prefer to return papers online, while the corresponding percentage for those over 25 years of age is only 7.1%. In contrast, in the study produced by Fredericksen et al. (2019), the results of which date back to 1999, the 16–25-year-olds were the least satisfied and the 36–45-year-olds were the most satisfied with on-line learning. The youngest (16–25) students also felt they were learning the least, while the 36–45-year-olds, from their perspective, learned the most (Fredericksen et al., 2019).

The COVID-19 pandemic has led to a rapid transition from in-person to online learning around the world. In connection with this, numerous research articles have already been published on such aspects as students' perceptions and attitudes towards online learning. Although our research relates to situations where a student voluntarily chooses an online learning opportunity, and hence the context differs from those of COVID-19-related research, these new studies provide a wealth of useful information about students' online learning experiences. Hussein et al. (2020) investigated undergraduate students' ($N = 45$) attitudes to emergency online learning in Abu Dhabi during COVID-19. According to their study, the aspects of emergency online learning that were most frequently considered positive were "cost- and time-effectiveness, safety, convenience and improved participation". In turn, the aspects of emergency online learning that were most frequently considered negative were "distraction and reduced focus, heavy workload, problems with technology and the internet, and insufficient support from instructors and colleagues" (Hussein et al., 2020). In turn, Malkawi et al. (2021) examined the satisfaction levels and attitudes of students at the United Arab Emirates University with respect to their e-learning and virtual classes during COVID-19. Their research showed that students were satisfied with e-learning and virtual lessons and the study did not find a significant difference between students' satisfaction level and, for example, gender or college (Science / Humanities and Social Sciences / Engineering and Information Technology). A significant difference was, however, found between students' satisfaction and attitudes and the educational level: fourth-year students were significantly more satisfied than first-year students (Malkawi et al., 2021).

Interaction in Online Learning

In the context of online courses, interaction becomes particularly important since the courses typically include less or not at all traditional classroom teaching, which means that teacher-student interaction and student-student interaction happens largely with the aid of technological tools. Interaction between teachers and students includes for example, discussions, asking and answering questions, and the teacher providing students with feedback. In the online learning context interaction can, for example, be both synchronous via videoconferences and online chats and asynchronous via e-mails and discussion boards (Alamri & Tyler-Wood, 2017). The Quality Framework promoted by the Online Learning Consortium suggests that appropriate, constructive and substantive interaction with the educators and peers is one of the key factors influencing student satisfaction in the context of online learning (Quality Framework: The student satisfaction pillar, n.d.).

In Alqurashi (2018) study on fully online courses it was found that good interaction with the course instructor and the learning content predicted higher satisfaction and perceived learning among university students. Learner-

learner interaction, in turn, was not found to be a significant predictor of satisfaction and perceived learning. Ishak et al. (2020) noticed that studying in the flipped learning classroom with the aid of asynchronous online video lectures offered university students more chances to interact with their peers and the instructor than traditional lectures. In the case of a study by Peytcheva-Forsyth et al. (2018) it was shown that there is a gender difference involved in whether a student wants to receive support from a teacher in an electronic environment. 50.6% of male respondents would like to receive support from their teacher in online learning either always or sometimes, compared with just over 90% of female respondents.

Game-Based Learning and Gamification

When online learning is undergoing development, one aspect may be related to the utilization of gaming features in online courses. *Game-based learning* means the "use of games to enhance the learning experience", while *gamification* means "adding game elements on a non-game situation" (Al-Azawi et al., 2016). A literature review by Antonaci et al. (2019) reveals that points, badges, levels, and narratives are some of the game elements used in online learning environments. Luo (2021) explored the topic of *educational gamification* by analysing 44 related articles. The study resulted in two redefinitions. According to the researcher's interpretation, *game elements* refers to "the obvious game-like elements that are frequently used in digital games or gamification, which are concrete nouns" and *gamification mechanisms* to "the underlying guidelines that make gamification activities engaging, which are abstract nouns that relate to humans' innate psychological needs". In Luo's analysis of the articles, she found that several factors such as goal, immediate feedback, challenge and reward make gamification engaging.

Gamification has emerged in recent years as one of the methods of enhancing students' engagement and motivation in online learning activities. Many studies have been devoted to the topic, and reviews of the literature have revealed that education and learning are actually the most common contexts of empirical research into gamification (Majuri et al., 2018). In the context of online learning, the effects of game design elements seem to be diverse. The literature review from Majuri et al. (2018) reveals that "a considerable majority of the reviewed studies reported mainly positively oriented results" but "there is also a significant amount of research with null or mixed results." Türkmen and Soybas (2019) studied the effect of gamification on students' attitudes and achievements in fifth-grade mathematics classes in Turkey. In their experiment they found no significant differences between the experiment group and the control group in terms of either achievements or attitudes. In contrast, Papp (2017) conducted an experiment using the concepts of gamification and involving six business communication classes of college students and two mathematics classes for grade four students in Canada. Papp found that in the case of both of the groups the students' motivation and engagement increased, and the students' experiences about learning with the use of gamification were positive. In addition, Faghihi et al. (2014) developed a gaming environment for college algebra in the US and got positive results of using it in their experiment.

Mathematics and Future Careers

As the topic of the online course to be developed is mathematics, it will also be worth looking at students' views and attitudes related to mathematics and studying mathematics. Student perceived utility value of particular courses or tasks from the perspective of one's future goals influences on students' behaviour and increases students' engagement in education (Eccles & Wigfield, 2002). Previous research has shown how students' value beliefs in mathematics tend to decline during adolescence (Watt, 2004). There are, however, very few studies in existence that investigate, in particular, upper secondary-level vocational school students' perceptions of the value of mathematics in terms of their future careers.

Dalby & Noyes (2015) studied groups of students in the construction and hairdressing in England. The results obtained from three large Further Education colleges showed that when the teaching and classroom pedagogy are organized in such a way that mathematics is integrated into the vocational experience, they "impact positively on student engagement and attitudes to learning mathematics".

In a recent Finnish national assessment of learning outcomes in mathematics in 9th grade, it was found that mathematics is generally perceived as useful (Metsämuuronen & Nousiainen, 2021). However, according to the results of the assessment, mathematics is not necessarily a subject to be liked.

Self-efficacy, Anxiety and Ability Self-perceptions in the Context of Studying Mathematics

Becoming aware of students' mathematics self-efficacy, mathematics anxiety and their self-perceptions of their mathematics ability is important when developing online courses and planning how to provide support in the online learning environment, especially for those students who struggle with the study of mathematics. Student *self-efficacy* is a notable element that needs to be considered when thinking about successful and satisfying online learning experiences, since self-efficacy beliefs affect performance expectations and behaviour. With respect to

mathematics self-efficacy, research conducted on particularly vocational school students' mathematics self-efficacy is marginal.

Yüksel & Geban (2015) focused on the prediction of vocational high school students' science and mathematics course achievements in terms of their self-efficacy and anxiety. Their study has shown that the variables predicting academic achievement differ according to course type. They found that student anxiety did not correlate with personal achievements in a chemistry or biology course. While *state anxiety* was observed to predict achievement in maths, *trait anxiety* predicted achievement in physics (see Yüksel & Geban (2015) for the explanation of the terms.). With regard to self-efficacy, their study found a positive correlation between academic self-efficacy and achievement in physics, chemistry and mathematics courses. In the case of a biology course, in turn, student self-efficacy predicted achievement. In a study by Zwart et al. (2020), senior secondary vocational school nursing students' mathematics self-efficacy decreased during a period of learning medical mathematics for which the students were required to use digital learning materials. Students' self-efficacy, however, did not affect their mathematics learning. Zwart et al. (2020) suggest that in the context of online education the teacher's role should not only encourage feedback as a part of completing assignments but also support students socially with respect to their sense of efficacy. Ozdemir & Onder-Ozdemir (2017) investigated Turkish Vocational and Technical High School students' ($N = 165$) *perceptions* as mathematics learners. Their study revealed that the reasons underlying students' perceptions were linked especially with students' perceived effect of their educational background on learning, perceived mathematics abilities and perceived behavior and actions in the mathematics course. In addition, students' views on their mathematics teacher and the milieu where the learning took place, were factors that influenced some students' perceptions.

Mathematics Learning Environments

When starting their vocational secondary education young students, in particular, may encounter completely unfamiliar learning environments regarding their study of mathematics. The items in our questionnaire related to the study of mathematics included three learning environments: online, an on-the-job training place, and a classroom. Previous research into vocational students' own views concerning the effect of learning environments on their mathematics learning is marginal. There is, however, research into the impact of learning environments on scores achieved in mathematics and also of knowledge of domain-specific mathematics in the context of vocational education. Zwart et al. (2017) studied the effect of Digital Learning Material (DLM) on the mathematics learning outcomes of apprenticeship students in vocational education in the Netherlands. They found that DLM which included, for example, instructional clips and online guidance "helped vocational education students improve their mathematics scores" and that "the implementation of DLM improved students' domain-specific mathematics knowledge for both numbers and proportion domains except for the geometry topic."

Frejd & Muhrman (2020) observed two mathematics lessons taught at an upper secondary vocational education and training school. One of the classes was conducted in a hairdressing salon (i.e., in a vocational classroom) and the other in a mathematics classroom. The researchers found that studying mathematics related to a specific field in an authentic environment rather than a conventional classroom increased discussion amongst the students about their mathematics topics. In the salon, for example, students were more likely to ask each other for help, while in a conventional mathematics classroom students expected the teacher to help (Frejd & Muhrman, 2020).

RESEARCH QUESTIONS

Our research is designed to help us develop an online course in mathematics that includes field-specific theoretical material, examples, learning assignments, and assessed assignments. The online course should permit students from different vocational fields to work along different learning paths. In order to produce learning paths that would be suitable for each field, there is a need to discover the views and expectations of students in different vocational fields with respect to online learning and mathematics. While many studies focus on online learning at the level of higher education, only limited research exists that focuses specifically on secondary level vocational students' views and expectations. Hence, the following research questions were drawn up:

1. How do students view online learning?
2. What do students expect from online learning?
3. What do students think of their own mathematics skills?
4. What do students expect from studying mathematics at vocational school?

All of the research questions are examined from the perspective of the various vocational fields.

METHODOLOGY

Data Collection Methods

A questionnaire was devised that would enable us to investigate Finnish upper secondary vocational school students' views and expectations regarding online learning and studying mathematics. The questionnaire was developed with the assistance of two online teachers from other subject areas, since there was also the intention to apply the results of the study to other online courses. The questionnaire was piloted with 18 students in Spring 2017. Following the pilot study, details of educational background were added to the demographic questions. A control question "Select 4 if you read this question" was also added in order to make sure that the students had really read the questions before responding. The parts of the questionnaire concerning online learning and studying mathematics did not require any modifications after piloting.

A total of 30 orientation information sessions, concerning either a combination of studying in a vocational school in general and online learning or online learning alone, were used to distribute the final version of the questionnaire. Approximately 920 students who were about to start their vocational upper secondary education participated in these sessions. At the start of the segment of the sessions concerning online learning the organizers introduced themselves and showed two short videos about online learning. Subsequently, the students answered the questionnaire using their mobile devices.

The questionnaire contained a total of 58 questions. Five of the questions were related to the students' demographic information, i.e., their gender, age, educational background, field of vocational education and training, and previous experience of online learning. In this study the demographic information as a point of interest lies in the field of vocational education and training. Two of the questions were designed for the purpose of checking the data later, if necessary. A total of 29 of the questions related to basic ICT skills, such as saving files onto the cloud service or knowing the basics of a spreadsheet programme, while two of the questions related to students' opinions concerning the usefulness of ICT skills. The results related to these issues were evaluated in our previous article (Suominen et al., 2021). In the present article 18 questions have been dealt with that related to students' views and expectations concerning online learning and studying mathematics. Additionally, students who wanted to participate in a subsequent lottery were asked in the final question of the questionnaire to leave their contact information.

Sample

A total of 865 students starting their upper secondary vocational education responded to the questionnaire. A total of 32 students answered the control question incorrectly and one of the students used a fake name. In addition, representatives (8 students) of the gender option "Other" had to be left out due to ambiguities related to the answers. Thus, the size of the final research material was 824 students. Of the respondents, 409 (49.6%) were female and 415 (50.4%) were male. The gender distribution of the respondents in their respective fields is shown in Table 1. Table 1 also shows the number of respondents in the various vocational fields.

Table 1. Percentage of female and male respondents in the various vocational fields[a]

Vocational field (number of respondents)	Percentage of female and male respondents
Agriculture and Forestry ($N = 27$)	25.9% - 74.1%
Business, Administration and Law ($N = 120$)	49.2% - 50.8%
Health and Welfare ($N = 179$)	79.9% - 20.1%
Humanities and Arts ($N = 128$)	48.4% - 51.6%
Information and Communication Technologies ($N = 32$)	9.4% - 90.6%
Service Industries ($N = 163$)	68.7% - 31.3%
Technology ($N = 175$)	13.1% - 86.9%

[a] Nowadays, the fields of Finnish vocational education and training are different than in 2017. Some vocational qualifications are, for example, located under different vocational fields, e.g., in 2017 vocational qualifications in ICT Technician and Property Maintenace Operative were part of Technology, Communication and Transportation. Nowadays, it should be noted, the former is part of Information and Communication Technologies, and the latter is part of Service Industries. All of the respondents are categorized according to current fields of vocational education and training. There were respondents from seven current vocational fields in our questionnaire survey.

The majority of respondents were 16–17 years old ($N = 367$, 44.5%), while the second most common age group consisted of those under 16 years of age ($N = 137$, 16.6%). The most common educational background of respondents was comprehensive school ($N = 584$, 70.9%). Only 32.8% ($N = 270$) of respondents had completed online studies before.

Data Analysis Methods

Two types of variables were used in our quantitative research. The field of vocational education and training was an independent variable, while the dependent variables consisted of students' opinions regarding the online learning and study of mathematics. The data analysis started with a calculation of the mean values and standard deviations for the students' responses in Likert scale questions. In addition, the percentages of respondents selecting the different options were calculated. Next, the Kruskal-Wallis test was used to find out if there were statistically significant differences between the responses of students from seven vocational fields. Question 43 was a multiple-choice question with several correct options to choose from. In connection with this question, the number of students who chose different options was investigated. The data was analyzed using IBM SPSS Statistics software (version 27) and the reporting of the results has been guided by Field (2018).

RESULTS

In this section, students' views and expectations concerning online learning and studying mathematics are examined in relation to our survey.

Students' Views and Expectations Concerning Online Learning

The means and standard deviations of views and expectations concerning online learning by field of vocational education are presented in Appendix A; the percentages of respondents selecting the options "completely disagree" or "disagree", "neither agree nor disagree" and "largely agree" or "completely agree" appear in Appendix B; and pairwise comparisons using the Kruskal-Wallis test are presented in Appendix C.

Use of Smartphones and a Computers in Studies

Consideration will be first paid to the use of smartphones and computers in the performance of studies. In the claim "I would be happy to use a phone for my studies", the means varied between $M = 3.26–3.74$, the percentages for the two best options "largely agree" or "completely agree" between 37.0–65.9%, and for the two worst options "completely disagree" or "disagree" between 9.2–26.6%. In light of the means, the percentages of two best options and the for the two worst options, Agriculture and Forestry ($M = 3.26$; 37.0%; 22.2%) and Humanities and Arts ($M = 3.26$; 46.1%; 26.6%), were most negatively related to the use of the smartphones in connection with the studies. In turn, the means and the percentages of the two best options for using a phone for the studies were highest in the fields of Service Industries ($M = 3.74$; 65.0%) and Health and Welfare ($M = 3.73$; 65.9%). These results are partly reflected in pairwise comparisons: In pairwise comparisons using the Kruskal-Wallis test two statistically significant pairwise comparisons appeared in the claim "I would be happy to use a phone for my studies" ($H(6) = 19.729$, $p = 0.003$). Students in Humanities and Arts were significantly less likely to suppose that they would be happy to use a phone for their studies compared with students in Service Industries ($p = 0.005$, $r = -0.21$) and Health and Welfare ($p = 0.009$, $r = -0.20$).

In the claim "I want to use a computer a lot in my future studies" Agriculture and Forestry had the lowest mean ($M = 3.00$) and the largest percentage for the two worst options (29.6%), while, as could have been predicted, Information and Communication Technologies had the highest mean ($M = 4.62$) and the largest percentage for the two best options (96.9%). When Information and Communication Technologies is omitted, Business, Administration and Law has the highest mean $M = 3.93$. This claim ($H(6) = 57.981$, $p = 0.000$) was significantly affected by the vocational field. Students in Information and Communication Technologies wanted to use computers a lot in their future studies significantly more often than did students from any of the other fields: Service Industries ($p = 0.000$, $r = -0.37$), Health and Welfare ($p = 0.000$, $r = -0.38$), Humanities and Arts ($p = 0.000$, $r = -0.39$), Technology ($p = 0.000$, $r = -0.45$), Agriculture and Forestry ($p = 0.000$, $r = -0.79$) and Business, Administration and Law ($p = 0.003$, $r = -0.31$). In addition, students in Business, Administration and Law wanted to use a computer a lot in their future studies significantly more often than did students from two other fields: Agriculture and Forestry ($p = 0.002$, $r = 0.32$) and Technology ($p = 0.002$, $r = 0.23$).

Attitudes to Online Learning

Next, attention will be paid to claims related to the opinions expressed about online learning. The means for the claim "Some of your studies will likely be independent online studies. Questions 42–48 relate to online learning. I would be happy to study online" varied between $M = 3.22–3.97$. Agriculture and Forestry and Humanities and Arts had the largest percentages for the two worst options (25.9% and 25.8%, respectively) and the lowest percentages for the two best options (48.1% and 49.2%, respectively) while Information and Communication Technologies and Business, Administration and Law had the lowest percentages for the two worst options (3.1% and 3.3%, respectively) and the largest percentages for the two best options (71.9% and 60.8%, respectively). There were no statistically significant differences between the vocational fields in the opinions expressed at $p > 0.05$ in this claim.

The claim "I believe online learning is a flexible way to study" had relatively high means (M = 3.48–4.25) and percentages for the two best options (51.9–81.3%). Only the means and percentages obtained for Agriculture and Forestry (M = 3.48; 51.9%) and Technology (M = 3.59; 57.1%) were below 3.80 and 65%, respectively. The percentages for the two worst options varied between 0.0–14.8%. When there were two statistically significant pairwise comparisons in total in this claim ($H(6)$ = 31.617, p = 0.000), Technology was included in both comparisons. Students from Technology were significantly less likely to agree with the claim than did students from Health and Welfare (p = 0.000, r = -0.24) and Information and Communication Technologies (p = 0.002, r = -0.27).

Interaction and Instructions in Online Learning

The questionnaire contained three claims related to interaction or instructions in an online learning environment. With respect to interaction with the teacher, students from the various vocational fields considered it quite important to be able to ask the teacher for help in the chat: In the claim "I want it to be possible in an online learning environment to ask for advice from an online teacher through chat" the means (M = 3.62–4.13) and the percentages for the two best options (54.9–81.0%) were relatively high and the percentages for the two worst options (3.1–7.4%) relatively low. The means and the percentages for the two best options show that the possibility of asking the teacher for help in chat was most important for students taking Health and Welfare (M = 4.13; 81.0%) and least important for students of Technology (M = 3.62; 54.9%). With respect to the claim "I want it to be possible in an online learning environment to ask for advice from an online teacher through chat", the opinions were significantly affected by the vocational field ($H(6)$ = 38.954, p = 0.000). Pairwise comparisons showed that there were significant differences between the opinions of students studying Technology and those studying Health and Welfare (p = 0.000, r = -0.30), Humanities and Arts (p = 0.001, r = 0.24) and Service Industries (p = 0.037, r = 0.17). Comparison of the mean ranks (see Appendix C) shows that students representing Technology were significantly less likely to agree with the claim than students from the other three vocational fields mentioned above. In addition, students from Health and Welfare were significantly more often than students from Business, Administration and Law of the opinion that the possibility to connect with their teacher via chat was important (p = 0.046, r = -0.18).

Chatting with other students in an online learning environment was not considered as important as the possibility to chat with the teacher. With respect to the claim "I want to chat with other students in an online learning environment" the means varied between M = 2.96–3.56, while the percentages for the two best options varied between 29.6–54.7% and for the two worst options between 9.4–25.9%. In pairwise comparisons using the Kruskal-Wallis test there appeared only one statistically significant pairwise comparison related to this claim ($H(6)$ = 18.661, p = 0.005). Students in Health and Welfare regarded chatting with other students in an online learning environment as significantly more important than did students in Technology (p = 0.004, r = -0.20).

The way in which question 43 was implemented differed from the other questions: The question was not a Likert question but multiple-choice, where students were permitted to choose several options. Table 2 shows the question set used for this item, the answer options, and the numbers and percentages of students who selected each option. The results show that the final option "Verbal instructions would be sufficient" was the most popular. It is noteworthy that many students who chose the last option had also chosen at least one other option. As many as 33 students chose all four options. According to the students' choices, "Read aloud" was by far the least preferred option.

Table 2. Number of respondents selecting the various options of multiple choice question 43: "How would you like the online learning instructions to be given? You can choose several options."

Option	Frequency and percentage of all respondents
Using pictures	385 (46.7%)
Read aloud	107 (13.0%)
As a video guide	320 (38.8%)
Verbal instructions would be sufficient	528 (64.1%)

The choices made for question 43 by field of vocational education are presented in Appendix D. It is noted that the option "Using pictures" was the most popular among students of Health and Welfare, while the option "Read aloud" was favoured by students of Service Industries and the option "As a video guide" by students in Humanities and Arts. In contrast, all of the three options were the least popular among students in Information and Communication Technologies (in the option "As a video guide" Service Industries received the same percentage). The percentages for the option "Verbal instructions would be sufficient" were remarkably high in all fields.

Students in Information and Communication Technologies chose this option most frequently, while students in Technology favoured it least.

Game-Based Learning and Gamification

The last three questions in the questionnaire related to online learning were about game-based learning and gamification. The claim "It would be nice if the online course had been made like a game" had relatively low means (M = 2.88–3.44). The percentages for the two best options varied between 25.9–53.1% and for the two worst options between 18.3–35.9%. There were no statistically significant differences between the vocational fields in the opinions at $p > 0.05$ in the claim "It would be nice if the online course had been made like a game".

In the claim "I want a learning game or software to give immediate feedback on my success" the means ranged from M = 3.33 (Agriculture and Forestry) to M = 3.80 (Health and Welfare). The percentages for this claim were distributed as follows: 40.6–63.3% for the two best options and 6.1–18.8% for the two worst options. In pairwise comparisons using the Kruskal-Wallis test two statistically significant pairwise comparison appeared for this claim ($H(6) = 24.464$, $p = 0.000$). The immediate feedback was significantly less important for the students in the field of Technology than for the students in Health and Welfare ($p = 0.001$, $r = -0.22$) or Humanities and Arts ($p = 0.002$, $r = 0.22$).

In the claim "I find it important to see my progress in a learning game, for example, described using different levels (e.g., bronze, silver, gold)" the means were M = 3.26–3.60, the percentages for the two best options 33.3–56.4% and for the two worst options 8.3–20.3%. In this claim ($H(6) = 13.593$, $p = 0.035$), students in Health and Welfare considered it significantly more important to see their progress described using different levels than did students in Technology ($p = 0.025$, $r = -0.17$).

A summary of Kruskal-Wallis analyses of online learning claims

When the Kruskal-Wallis test was used in pairwise comparisons, there appeared statistically significant differences between some vocational fields in 7 claims out of 9. When there were 20 statistically significant pairwise comparisons in total, Technology was involved in 11 of those cases. In all of these cases, the mean rank of Technology was lower than that of the other field in the pairwise comparison. This means that students in the field of Technology were less enthusiastic about, for example, the various interaction possibilities in the online learning environment offered than were students in some of the other fields.

Students' Views and Expectations concerning Studying Mathematics

The means and standard deviations of views and expectations concerning studying mathematics according to the various fields of vocational education are presented in Appendix E. Similarly, the percentages of respondents selecting the options "completely disagree" or "disagree", "neither agree nor disagree" and "largely agree" or "completely agree" in Appendix F and pairwise comparisons using the Kruskal-Wallis test are presented in Appendix G.

Mathematics and Future Careers

First, consideration will be paid to claims related to the connection between mathematics (taught in vocational training) and students' future careers. Generally speaking, mathematics was seen as relatively important for future careers. For the claim "Questions 50–56 deal with the connection between mathematics and your future career and studying mathematics. I will need mathematics in my future career" the means were M = 3.80–4.35, the percentages for the two best options 64.8–83.8% and the percentages for the two worst options 0.0–9.4%. Humanities and Arts had the lowest mean (M = 3.80), the largest percentage for the two worst options (9.4%) and the lowest percentages for the two best options (64.8%). When Humanities and Arts is omitted, the percentages for the two worst options were only 0.0–2.5%. This claim ($H(6) = 43.524$, $p = 0.000$) was significantly affected by the vocational field. When there was a total of 4 statistically significant pairwise comparisons in this claim, Health and Welfare was involved in 3 of them. Students in the field of Health and Welfare were significantly more likely to suppose that they were going to need mathematics in their future careers, compared with students in Service Industries ($p = 0.000$, $r = -0.24$), Humanities and Arts ($p = 0.000$, $r = -0.32$) and Information and Communication Technologies ($p = 0.030$, $r = 0.22$). In addition, students in Humanities and Arts were significantly less likely to suppose that they were going to need mathematics in their future careers than were students in Business, Administration and Law ($p = 0.001$, $r = -0.25$).

The students from various vocational fields did not agree with the claim "I want to study mathematics more than the jobs of my future career would require". The means were M = 2.36–2.78, the percentages of the two best options 12.9%–22.2%, and the percentages for the two worst options 34.3–55.5%. Based on pairwise comparisons, students representing Business, Administration and Law approached the study of mathematics to a level beyond

the requirements of their future careers significantly more positively than did students from Humanities and Arts ($p = 0.027$, $r = -0.20$) or Service Industries ($p = 0.030$, $r = 0.19$).

The two claims "It is enough for me that the stories, examples and tasks involved in studying mathematics are related to everyday life and work tasks in someone else's field, they do not have to be related to my own field" and "It is important that the mathematics taught in vocational training (stories, examples, and assignments) is closely related to the work assignments in my own field" were the opposite of each other, and this is reflected in the students' responses. The means varied between $M = 2.84–3.31$ for the first of these two claims and $M = 3.31–3.73$ for the second. The percentages for the two worst options were 12.5–31.8% for the first of these two claims and 0.0–10.9% for the second. The percentages for the two best options were 20.1–37.5% and 34.4–64.8%, respectively. There were no statistically significant differences between the vocational fields in the opinions at $p > 0.05$ in the claim "It is enough for me that the stories, examples and tasks of studying mathematics are related to everyday life and work tasks in someone else's field, they do not have to be related to my own field". For the claim "It is important that the mathematics taught in vocational training (stories, examples, and assignments) is closely related to the work assignments in my own field" ($H(6) = 58.865$, $p = 0.000$), students from Health and Welfare were significantly more likely to think that it was important that the mathematics taught in vocational educations is closely related to the work assignments in their own field compared with students in Business, Administration and Law ($p = 0.004$, $r = -0.22$) and Service Industries ($p = 0.047$, $r = -017$).

Ability Self-perceptions and Self-efficacy in the Context of Studying Mathematics and the Perceived Need for Support

In this section attention will be paid to students' views regarding the relative easiness with which mathematics could be learned and the need for support in studying mathematics. For the claim "Mathematics is easy for me" the means were $M = 2.93–3.41$, the percentages for the two worst options 11.1–35.9%, and the percentages for the two best options 30.7–40.6%. Health and Welfare had the lowest mean and the lowest percentage for the two best options, while Agriculture and Forestry had the highest mean and the lowest percentage for the two worst options. There were no statistically significant differences between the vocational fields in the opinions at $p > 0.05$ in this claim.

In turn, the claim "I need support in studying mathematics (e.g., from a teacher, a classmate, parents)" was significantly affected by vocational field. Health and Welfare had the highest mean $M = 3.31$, while for the other vocational fields the means for this claim varied between $M = 2.56$ and $M = 3.03$. Health and Welfare also had the lowest percentage (24.6%) for the two worst options (other fields: 31.9–46.9%) and the highest percentage (46.9%) for the two best options (other fields: 18.5–38.7%). When there were three statistically significant pairwise comparisons in total for this claim ($H(6) = 27.609$, $p = 0.000$), Health and Welfare was included in every comparison. Students of Health and Welfare felt the need for support in studying mathematics significantly more frequently than did students of Business, Administration and Law ($p = 0.002$, $r = -0.23$), Technology ($p = 0.006$, $r = -0.19$) and Information and Communication Technologies ($p = 0.016$, $r = 0.23$). It should be noted, however, that in light of the means, the need for support was not remarkable high in any vocational field.

Mathematics Learning Environments

Finally, consideration will be paid to students' opinions of mathematics learning environments. In the claim "Studying mathematics online sounds like an interesting opportunity", Humanities and Arts had the lowest mean ($M = 2.87$) and the largest percentage for the two worst options (34.4%) while Business, Administration and Law had the highest mean ($M = 3.49$) and the largest percentage for the two best options (47.5%). There was only one statistically significant pairwise comparison for this claim ($H(6) = 17.903$, $p = 0.000$), and it was between the various fields listed above ($p = 0.002$, $r = -0.25$).

Humanities and Arts also had the lowest mean ($M = 2.50$) and the largest percentage for the two worst options (46.1%) for the claim "I want to study mathematics in an on-the-job training place rather than a classroom". Agriculture and Forestry had the highest mean ($M = 3.44$), the lowest percentage for the two worst options (11.1%), and the largest percentage for the two best options (37.0%). Students in Humanities and Arts expressed the opinion with significantly less frequency ($H(6) = 21.932$, $p = 0.001$) that they wanted to study mathematics in an on the-job-training place rather than a classroom than did students in Agriculture and Forestry ($p = 0.001$, $r = -0.33$) or Technology ($p = 0.020$, $r = -0.19$).

A summary of Kruskal-Wallis Analyses of Mathematics Claims

When the Kruskal-Wallis test was used in pairwise comparisons, there appeared statistically significant differences between some vocational fields in 6 claims out of 8. When there were 14 statistically significant pairwise comparisons in total, Health and Welfare was involved in 8 of those cases. In all of these cases, the mean rank of

Health and Welfare was higher than that of the other field in the pairwise comparison. In these claims, it should be noted that high mean rank signified different things, depending on the claim. A high mean rank could, for example, signify a student's perception that mathematics is important for his or her future career, while, on the other hand, the student felt they needed support in studying mathematics.

DISCUSSION

New vocational students' views and expectations concerning online learning and studying mathematics have been examined in this study. Of particular interest were the differences between the views and expectations of students in seven different vocational fields. This study will contribute to the research into the development of online courses, especially in mathematics but also in other subjects, and the organization of mathematics studies designed for vocational upper secondary level students.

Research question 1, "How do students view online learning?", can be considered first from the perspective of how students view the use of two devices used in online learning, a smartphone and a computer, in their own studies. Although previous research (e.g., Sincuba & John, 2017; Yang, 2012) has found that students have positive attitudes toward mobile learning, it is also clear that not all students representing all of the vocational fields in our survey were initially very enthusiastic about using their phones in their studies. Students in Humanities and Arts were significantly less likely to suppose that they would be happy to use phones in their studies, compared with students in Service Industries and Health and Welfare. In turn, students' views on whether they wanted to use computers extensively in their studies depended significantly on what vocational field the students were representing. As expected, students in Information and Communication Technologies were willing to use computers extensively in their future studies, especially in comparison with students in any of the other fields.

Attention was paid in our previous article to students' perceptions of their own basic ICT skills (Suominen et al., 2021). According to the results of our survey it was found that students in all fields felt that they were very familiar with how to take photos on a smartphone. Thus, if it can be assumed that this is true, assignments could be set in a mathematics online course that would require students to take photographs of mathematical work tasks appropriate to their field. However, if some students are of the opinion that they do not particularly enjoy using a phone for study purposes, ways should also be found to design online learning activities that might help students to realise the potential of the phone as a convenient learning tool. It can be assumed that if the use of particular tools is not to be considered a problem, students will be better able to focus on acquiring a proper working knowledge of the substance of mathematics, for example. The same holds true with regard to using a computer. Although some studies show that students make more use of a phone than a computer in their online studies (Sungjeminla, 2022; Yan et al., 2021), it is known from experience that our students nevertheless frequently work on their online studies with the aid of a computer. One reason for this is that many online learning activities work better on a computer. In addition, although raising the compulsory school age in Finland does not directly mean that students will automatically have access to computers, the Ministry of Education and Culture (2021) has also answered questions related to the topic that "it has been estimated in the cost calculations of the reform that, to be able to participate in instruction, each student should be equipped with a computer for the duration of their studies". Thus, as more and more young students have access to a (laptop) computer provided by an educational institution, it would be important for them to also discover how much more effective using a computer can be if it is used for study purposes.

Further consideration of research question 1 reveals that, generally speaking, students from the different vocational fields considered online learning to be quite a flexible way to study. Students in the fields of Agriculture and Forestry and Technology were the least likely to agree with the statement, especially those of Technology. Because online learning is often independent of time and place, in our experience it is frequently flexibility that is one of the positive features associated with online learning. It was found in an earlier study undertaken in Finland that for upper secondary school students (N = 58) flexibility of timetables was one of the reasons for favouring online studies (Kokko et al., 2021). But as can be seen from the present results, while students obviously see online learning as a flexible way of studying, they were less likely to agree with the statement "I would be happy to study online". However, the students' attitude was also found to be cautiously positive, and there was no statistically significant difference between the various fields with regard to this claim. It is also worth remembering that only a third of our respondents had previously completed any online studies. Katz et al. (2002) noticed that even if students were nervous about the nature of an Internet-based course, they were nevertheless capable of dealing with such a course successfully. Hence, it would be important to discover whether students' views about online learning change once they have experienced this mode of studying, especially if the outcome has been personally successful.

Research question 2 addresses students' expectations of online learning and relates, for example, to interaction and instructions. Results show that students from the various vocational fields expected that in an online learning environment they would be able to ask a teacher for help by means of chat. Students in the field of Health and Welfare considered this opportunity particularly important, while those in the field of Technology rated it as least important. In general, it was considered that chatting with other students in an online learning environment was less important than the possibility of chatting with the teacher. Students from Health and Welfare regarded chatting with other students in an online learning environment as significantly more important than did students in the field of Technology. These views are in line with the results reported by Alqurashi (2018), who found that in the context of fully online courses good interaction with instructor of the course and the learning content predicted higher satisfaction and perceived learning among university students. Learner-learner interaction, in turn, was not found to be such an important predictor of satisfaction or perceived learning in Alqurashi's (2018) study. In the case of our previous study (Suominen et al., 2021), it was found that students in Health and Welfare more frequently rated their basic ICT skills as weak than did students in many other vocational fields. The fact that students of Health and Welfare wanted a conversation to be possible in an online learning environment with both their teachers and with their fellow-students may be related to this uncertainty about information technology per se. Furthermore, the new unified assessment criteria in the common units of the vocational upper secondary qualification in Finland, brought into use in August 2022, include an assessment criterion related to the interaction itself (Finnish National Agency for Education, 2021a). The criteria are defined for grades 1–5. For example, a satisfactory assessment criterion grade of 1 for interaction is defined as "the student acts appropriately in familiar interactive situations", a good assessment grade of 3 means that "the student acts collaboratively in usual interactive situations", while a commendable assessment of 5 reveals that "the student acts collaboratively and constructively in varying interactive situations" (Finnish National Agency for Education, 2021b). Thus, different interaction situations and their evaluation play an increasingly important role also in online learning.

Regarding the presentation of the instructions for online learning, a majority of students in all fields chose the option "verbal instructions would be sufficient". Of the three other ways in which instructions were offered, by far the least popular was "read aloud". It is notable that many of the students who chose the option "verbal instructions would be sufficient" had also chosen at least one other option. It would be interesting to know if their choices were based on the idea that video instructions, for example, would be quite nice but that verbal instructions would suffice. Since more than 50% of the respondents in both Humanities and Arts and Health and Welfare chose instructions that used pictures, and since more than 50 % of the Humanities and Arts respondents expressed a preference for video instructions, it may well be worth considering providing instructions in both formats for future online courses.

With respect to research question 2, students in the various vocational fields did not expect an online course to be made like a game. In addition, students did not regard it as particularly important that in a learning game, for example, they should have the opportunity to see their progress expressed in terms of different levels (e.g., bronze, silver, gold). Immediate feedback on a student's success in an online learning game or software was regarded as the most important of the three claims related to game-based learning and gamification. This finding related to importance of immediate feedback is in line with Luo's findings (2021): When Luo looked at the articles related to the gamification in depth, she found that immediate feedback makes gamification engaging. In our research the immediate feedback was significantly less important for students in the field of Technology than for those in Health and Welfare or Humanities and Arts. Health and Welfare students also considered it to be significantly more important to see their progress described using different levels than did students in Technology.

Turning now to research question 3, which concerned students' perceptions of their own mathematics skills, there were no statistically significant differences between the vocational fields as to whether students felt that mathematics was easy for them. Although the need for support in studying mathematics was not remarkable high in any vocational field, students' experience of the need for support was significantly affected by their vocational field. Students from Health and Welfare felt the need for support in studying mathematics from a teacher, a classmate or parents, for example, significantly more frequently than did students from the other three vocational fields. As can be seen from Table 1, Health and Welfare is a very female-dominated field. Two of the vocational fields whose students experienced the least need for support (Technology and Information and Communication Technologies) were, in turn, male-dominated fields. Thus, it may be that gender is a significant factor in our consideration of the reasons for the differing needs for support. This view is indeed supported by the results of a recent Finnish national assessment of learning outcomes in mathematics in the 9th grade (Metsämuuronen & Nousiainen, 2021). According to findings of assessment, no difference exists between the genders in their overall knowledge of mathematics. However, the national assessment showed that as they have found in the course of the past ten years, girls undergo a significantly worse experience than do boys in terms of their mathematical skills. In other words, girls have a weaker mathematics self-efficacy than boys.

Research question 4 addresses students' expectations regarding the study of mathematics at a vocational school, for example, in terms of learning materials and learning environments. According to our results, students clearly want to study mathematics no more than their own career requires. The most positive attitude towards studying extra mathematics is maintained by students of Business, Administration and Law. It was also noticed that, although it is not remarkably important for the students from across the range of different vocational fields, that the mathematical examples and tasks discussed were related to their own field, it is obvious from the responses that students prefer to deal with mathematics through cases in their own field rather than examples drawn from general working life. The integration of mathematics into one's own field was especially important for students in the field of Health and Welfare. It is clear from the literature that the integration of mathematics into the field has had a positive impact on students' experience of studying mathematics at vocational school (Frejd & Muhrman, 2020; Dalby & Noyes, 2016). Current vocational upper secondary qualification requirements in Finland include four competence points for obligatory mathematics. There have been five targeted learning outcomes, including 14 assessment criteria in total in obligatory mathematics. Many of these criteria have included at least a mention of the individual student's own vocational field or working life in general. Instead, the targeted learning outcomes for mathematics in the new qualification requirements brought into use in August 2022 no longer contain any reference to the student's own vocational field, since references to working life are more common. It remains to be seen how this reform will affect the teaching of mathematics in Finland and thus students' attitudes towards mathematics in vocational education. The fact that students do not want to study mathematics to any more advanced level than is required by specific jobs in their field may be related to the fact that mathematics is not necessarily considered a subject to be liked. The above findings and conclusions are confirmed by the national assessment in Finland of learning outcomes in mathematics in the 9th grade (Metsämuuronen & Nousiainen, 2021). According to the assessment results, mathematics is generally perceived as useful but it is not necessarily a subject to be liked.

With respect to learning environments, students in the Humanities and Arts are the most skeptical concerning the idea of studying mathematics online or in an on-the-job learning place. In general, no students in any field reported themselves to be especially positive about the two learning environment options offered. Students in Agriculture and Forestry and Technology were the most positive about learning mathematics in the workplace. This may be because in many areas of technology mathematics is essentially work-related. Studying mathematics in the context of vocational subjects has been found to increase students' motivation vis-à-vis mathematics (Frejd & Muhrman, 2020). This option was not available in our questionnaire, so it would be interesting to discover whether students would be more positive about studying mathematics in a work environment if the study took place in a vocational class rather than in addition to on-the-job training.

In summary, when looking at statistically significant pairwise comparisons in claims concerning online learning, it can be observed that students in Health and Welfare and in Technology often have different views about particular issues. Students in Health and Welfare, with statistically greater frequency, believe that online learning is a flexible way to study, want to have the opportunity in an online learning environment to ask for advice from an online teacher through chat and chat with fellow-students, want a learning game or software to provide them with immediate feedback on their success and regard it as important that they see their progress in a learning game, than do students of Technology. It has been noticed previously that students of Health and Welfare rate their personal basic ICT skills as significantly lower than do students in many other vocational fields (Suominen et al., 2021). Hence, the need for interaction and for diverse indicators of success may be associated with this uncertainty with basic ICT skills. On the other hand, it should be noted that uncertainty about basic ICT skills is not reflected in their assessment of online learning flexibility. With regard to the noticeably more negative attitude amongst students in the field of Technology, similar results were reported in our previous article concerning the need for IT skills: students in Technology felt that they need IT skills in their future careers significantly less frequently than did students in Humanities and Arts and in Health and Welfare (Suominen et al., 2021).

Health and Welfare also emerges in pairwise comparisons related to mathematics. Students in Health and Welfare are significantly more likely to suppose that they are going to need mathematics in their future career, that it is important that the mathematics taught in vocational training is closely related to the work assignments in their field, and that they need greater support in studying mathematics than students in many other fields. While students in Health and Welfare feel that mastering mathematics is important for their future careers and at the same time feel that they need help significantly more frequently in studying mathematics than do students in many other fields, it is important that they are provided with adequate support during their mathematics studies. It is also important to consider the role of gender in the experience of needing support. As mentioned before in this section, the results of the recent Finnish national assessment of learning outcomes in mathematics in the 9th grade show that girls have a weaker mathematics self-efficacy than boys (Metsämuuronen & Nousiainen, 2021). As some of

the fields in upper secondary vocational education are dominated by male students and others by female students, differences in mathematics self-efficacy amongs students in different fields of vocational education are likely to occur. Becoming aware of the needs of students in different fields promotes the quality of vocational education. In terms of future research, further investigations should be conducted particularly into vocational students' mathematics self-efficacy. Gender differences also occur, for example, in self-assessments related to web-use skills: According to observations made by Hargittai & Shafer (2006), women rated their skills as worse than those of men, although there were in fact no great differences in their real skills. Hence, it is important to recognize that both aspects of our research, mathematics and online activities, may involve a gender perspective.

It is worth remembering that only a third of respondents had completed online studies previously. In future research it would be useful to determine how students' experience of online learning affects their attitudes to online learning itself and also to the devices used in online learning and the aspirations connected with online learning. The same holds true for studying mathematics. Few students who responded to the questionnaire are likely to have had previous experience of studying mathematics in on-the-job training, so that their perception of the importance of mathematics for their future careers is based on their imagination. It should be noted that most of the students who responded to the questionnaire had come directly from comprehensive school to study for vocational upper secondary qualifications.

With respect to the further development of online courses, such as mathematics, but also in other fields, it will be important to discover students' opinions regarding the different solutions suggested by a pilot online mathematics course. Particular attention is being paid at present to whether students at the vocational upper secondary level take advantage of the recurrence opportunity. It will also be useful to find out what students think about the instructional video produced for the pilot study. It is known that major gaps may be present in the mathematics skills of students entering vocational education. An article by Lindberg & Grevholm (2011) deals with a developmental research project (the KAM-project, where in English KAM means "the mathematics of vocational subjects") which was conducted in Sweden in 1998–2002. In connection with the KAM-project, it had been noticed that although the students had previously passed their mathematics courses in their earlier formal schooling and had thus acquired the knowledge laid out in the curriculum, they did not have the necessary basic knowledge once they started their vocational training. There was already a learning deficiency in the mathematics syllabus covered at the beginning of their basic schooling, such as fractions. According to the article, the solution may be to ensure that students actually acquire adequate skills in their basic schooling rather than to lower the level of requirements for the first mathematics course (Lindberg & Grevholm, 2011). In turn, the recent Finnish national assessment of learning outcomes in mathematics in the 9th grade shows that that the level of mathematics competence has fallen significantly in comparison with previous assessments (Metsämuuronen & Nousiainen, 2021). According to the national assessment, some of the most recent decline in skills may be explained by the COVID-19 pandemic but, on the other hand, skills have actually been in decline since 2001. In our online studies it will be possible for students to reinforce their previously acquired skills in repetition paths, but it is clear that no amount of repetition paths can make up for major gaps in basic knowledge.

CONCLUSION

According to our results, students from different vocational fields entering vocational education regard online learning as a quite flexible way to study. They expect to be able to ask for advice from an online teacher through chat, but they don't expect an online course to be made like a game. Students feel that they need mathematics in their future career, but they do not want to study it more than the jobs in their future careers would require. Students do not desire to study mathematics in an on-the-job training place rather than in a classroom, and studying mathematics online is not considered to be a very attractive option. As a rule, students do not feel that they need help in studying mathematics, for example from their teachers or parents. However, in all of these situations there are significant differences between some vocational fields, and hence the differences between the various fields should be taken into account when planning online learning and mathematics education in vocational education.

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APPENDIX A

Views and expectations of students entering vocational education (N = 824) concerning online learning, means and standard deviations (1 = completely disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = largely agree, 5 = completely agree).

Claim		Humanities and Arts (N = 128)	Business, Administration and Law (N = 120)	Agriculture and Forestry (N = 27)	Service Industries (N = 163)	Technology(N = 175)	Health and Welfare (N = 179)	Information and Communication Technologies (N = 32)
I would be happy to use a phone for my studies.	***M***	3.26	3.62	3.26	3.74	3.63	3.73	3.66
	S. D.	1.212	0.980	1.163	1.086	1.024	1.014	1.125
I want to use a computer a lot in my future studies.	***M***	3.65	3.93	3.00	3.66	3.46	3.65	4.62
	S. D.	1.240	0.842	1.209	1.050	0.945	0.913	0.554
Some of your studies will likely be independent online studies. Questions 42–48 relate to online learning. I would be happy to study online.	***M***	3.36	3.79	3.22	3.63	3.44	3.62	3.97
	S. D.	1.272	0.819	1.281	1.043	1.015	0.989	0.822
I believe online learning is a flexible way to study.	***M***	3.80	3.90	3.48	3.85	3.59	4.02	4.25
	S. D.	0.991	0.782	1.122	0.957	0.866	0.761	0.762
I want it to be possible in an online learning environment to ask for advice from an online teacher through chat.	***M***	4.01	3.83	3.63	3.90	3.62	4.13	4.00
	S. D.	0.926	0.895	0.884	0.914	0.861	0.828	0.803
I want to chat with other students in an online learning environment.	***M***	3.41	3.33	2.96	3.36	3.19	3.56	3.37
	S. D.	1.125	0.929	1.126	1.016	0.906	0.943	0.907
It would be nice if the online course had been made like a game.	***M***	2.88	3.16	2.96	3.15	3.06	3.21	3.44
	S. D.	1.296	0.953	1.055	1.118	0.954	1.110	1.190
I want the learning game or software to	***M***	3.79	3.66	3.33	3.57	3.39	3.80	3.59

give immediate feedback on my success.	***S. D.***	1.017	0.845	1.074	1.048	0.964	0.902	1.073
I find it important to see my progress in the learning game, for example, described using different levels (e.g., bronze, silver, gold).	***M***	3.34	3.50	3.26	3.49	3.27	3.60	3.53
	S. D.	1.173	0.889	1.059	0.952	0.961	1.025	1.016

APPENDIX B

Views and expectations of students entering vocational education ($N = 824$) concerning online learning, numbers and percentages of responses to "completely disagree" or "disagree" (A), "neither agree nor disagree" (B) and "largely agree" or "completely agree" (C).

Claim		**Humanities and Arts ($N = 128$)**	**Business, Administration and Law ($N = 120$)**	**Agriculture and Forestry ($N = 27$)**	**Service Industries ($N = 163$)**	**Technology ($N = 175$)**	**Health and Welfare ($N = 179$)**	**Information and Communication Technologies ($N = 32$)**
I would be happy to use a phone for my studies.	**A**	34 (26.6%)	11 (9.2%)	6 (22.2%)	22 (13.5%)	22 (12.6%)	23 (12.8%)	5 (15.6%)
	B	35 (27.3%)	44 (36.7%)	11 (40.7%)	35 (21.5%)	45 (25.7%)	38 (21.2%)	9 (28.1%)
	C	59 (46.1%)	65 (54.2%)	10 (37.0%)	106 (65.0%)	108 (61.7%)	118 (65.9%)	18 (56.3%)
I want to use a computer a lot in my future studies.	**A**	19 (14.8%)	6 (5.0%)	8 (29.6%)	19 (11.7%)	24 (13.7%)	19 (10.6%)	0 (0.0%)
	B	35 (27.3%)	26 (21.7%)	10 (37.0%)	46 (28.2%)	60 (34.3%)	53 (29.6%)	1 (3.1%)
	C	74 (57.8%)	88 (73.3%)	9 (33.3%)	98 (60.1%)	91 (52.0%)	107 (59.8%)	31 (96.9%)
Some of your studies will likely be independent online studies. Questions 42–48 relate to online learning. I would be happy to study online.	**A**	33 (25.8%)	4 (3.3%)	7 (25.9%)	21 (12.9%)	27 (15.4%)	22 (12.3%)	1 (3.1%)
	B	32 (25.0%)	43 (35.8%)	7 (25.9%)	46 (28.2%)	61 (34.9%)	50 (27.9%)	8 (25.0%)
	C	63 (49.2%)	73 (60.8%)	13 (48.1%)	96 (58.9%)	87 (49.7%)	107 (59.8%)	23 (71.9%)
I believe online learning is a flexible way to study.	**A**	11 (8.6%)	3 (2.5%)	4 (14.8%)	13 (8.0%)	13 (7.4%)	3 (1.7%)	0 (0.0%)
	B	33 (25.8%)	31 (25.8%)	9 (33.3%)	40 (24.5%)	62 (35.4%)	38 (21.2%)	6 (18.8%)
	C	84 (65.6%)	86 (71.7%)	14 (51.9%)	110 (67.5%)	100 (57.1%)	138 (77.1%)	26 (81.3%)

I want it to be possible in an online learning environment to ask for advice from an online teacher through chat.	**A**	7 (5.5%)	6 (5.0%)	2 (7.4%)	6 (3.7%)	11 (6.3%)	7 (3.9%)	1 (3.1%)
	B	27 (21.1%)	36 (30.0%)	8 (29.6%)	44 (27.0%)	68 (38.9%)	27 (15.1%)	7 (21.9%)
	C	94 (73.4%)	78 (65.0%)	17 (63.0%)	113 (69.3%)	96 (54.9%)	145 (81.0%)	24 (75.0%)
I want to chat with other students in an online learning environment.	**A**	24 (18.8%)	19 (15.8%)	7 (25.9%)	24 (14.7%)	27 (15.4%)	20 (11.2%)	3 (9.4%)
	B	42 (32.8%)	52 (43.3%)	12 (44.4%)	65 (39.9%)	89 (50.9%)	61 (34.1%)	14 (43.8%)
	C	62 (48.4%)	49 (40.8%)	8 (29.6%)	74 (45.4%)	59 (33.7%)	98 (54.7%)	15 (46.9%)
It would be nice if the online course had been made like a game.	**A**	46 (35.9%)	22 (18.3%)	7 (25.9%)	40 (24.5%)	39 (22.3%)	40 (22.3%)	9 (28.1%)
	B	39 (30.5%)	60 (50.0%)	13 (48.1%)	62 (38.0%)	85 (48.6%)	66 (36.9%)	6 (18.8%)
	C	43 (33.6%)	38 (31.7%)	7 (25.9%)	61 (37.4%)	51 (29.1%)	73 (40.8%)	17 (53.1%)
I want a learning game or software to give immediate feedback on my success.	**A**	10 (7.8%)	9 (7.5%)	4 (14.8%)	19 (11.7%)	18 (10.3%)	11 (6.1%)	6 (18.8%)
	B	37 (28.9%)	37 (30.8%)	12 (44.4%)	55 (33.7%)	86 (49.1%)	55 (30.7%)	9 (28.1%)
	C	81 (63.3%)	74 (61.7%)	11 (40.7%)	89 (54.6%)	71 (40.6%)	113 (63.1%)	17 (53.1%)
I find it important to see my progress in a learning game, for example, described using different levels (e.g., bronze, silver, gold).	**A**	26 (20.3%)	10 (8.3%)	4 (14.8%)	19 (11.7%)	23 (13.1%)	21 (11.7%)	5 (15.6%)
	B	49 (38.3%)	50 (41.7%)	14 (51.9%)	61 (37.4%)	85 (48.6%)	57 (31.8%)	12 (37.5%)
	C	53 (41.4%)	60 (50.0%)	9 (33.3%)	83 (50.9%)	67 (38.3%)	101 (56.4%)	15 (46.9.%)

APPENDIX C

Views and expectations of students entering vocational education ($N = 824$) concerning online learning, pairwise comparisons using the Kruskal-Wallis test.

Claim	**Pairwise comparisons using the Kruskal-Wallis test**	
	Fields and their mean ranks	***p*-value (Adj. Sig.)**
I would be happy to use a phone for my studies.	Humanities and Arts (346.38) - Health and Welfare (439.15)	0.009
	Humanities and Arts (346.38) - Service Industries (444.82)	0.005
	Agriculture and Forestry (279.56) - Business, Administration and Law (466.46)	0.002

I want to use a computer a lot in my future studies.	Agriculture and Forestry (279.56) - Information and Communication Technologies (639.84)	0.000
	Technology (360.22) - Business, Administration and Law (466.46)	0.002
	Technology (360.22) - Information and Communication Technologies (639.84)	0.000
	Health and Welfare (401.83) - Information and Communication Technologies (639.84)	0.000
	Service Industries (411.32) - Information and Communication Technologies (639.84)	0.000
	Humanities and Arts (421.02) - Information and Communication Technologies (639.84)	0.000
	Business, Administration and Law (466.46) - Information and Communication Technologies (639.84)	0.003
Some of your studies will likely be independent online studies. Questions 42–48 relate to online learning. I would be happy to study online.	There were no statistically significant pairwise comparisons (even though p = 0.011)	
I believe online learning is a flexible way to study.	Technology (347.67) - Health and Welfare (455.09)	0.000
	Technology (347.67) - Information and Communication Technologies (516.72)	0.002
I want it to be possible in an online learning environment to ask for advice from an online teacher through chat.	Technology (339.18) - Service Industries (415.59)	0.037
	Technology (339.18) - Humanities and Arts (446.22)	0.001
	Technology (339.18) - Health and Welfare (475.11)	0.000
	Business, Administration and Law (394.08) - Health and Welfare (475.11)	0.046
I want to chat with other students in an online learning environment.	Technology (369.56) - Health and Welfare (459.68)	0.004
It would be nice if the online course had been made like a game.	There were no statistically significant pairwise comparisons (p = 0.144)	
I want a learning game or software to give immediate feedback on my success.	Technology (353.53) - Health and Welfare (451.58)	0.001
	Technology (353.53) - Humanities and Arts (455.70)	0.002
I find it important to see my progress in a learning game, for example, described using different levels (e.g., bronze, silver, gold).	Technology (373.78) - Health and Welfare (451.64)	0.025

APPENDIX D

Number of respondents from the various fields in the various options of multiple choice question 43: "How would you like the online learning instructions to be told? You can choose several options."

Vocational field (frequency of respondents)	Frequency and percentage of respondents of the field for option			
	Using pictures	Read aloud	As a video guide	Verbal instructions would be sufficient
Agriculture and Forestry (*N* = 27)	8 (29.6%)	4 (14.8%)	8 (29.6%)	18 (66.7%)
Business, Administration and Law (*N* = 120)	44 (36.7%)	7 (5.8%)	40 (33.3%)	89 (74.2%)
Health and Welfare (*N* = 179)	95 (53.1%)	31 (17.3%)	79 (44.1%)	106 (59.2%)
Humanities and Arts (*N* = 128)	67 (52.3%)	17 (13.3%)	68 (53.1%)	83 (64.8%)
Information and Communication Technologies (*N* = 32)	10 (31.3%)	0 (0.0%)	10 (31.3%)	26 (81.3%)
Service Industries (*N* = 163)	79 (48.5%)	29 (17.8%)	51 (31.3%)	104 (63.8%)
Technology (*N* = 175)	82 (46.9%)	19 (10.9%)	64 (36.6%)	102 (58.3%)

APPENDIX E

Perceptions of students entering vocational education (*N* = 824) concerning studying mathematics, means and standard deviations (1 = completely disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = largely agree, 5 = completely agree).

Claim		**Humanities and Arts (*N* = 128)**	**Business, Administration and Law (*N* = 120)**	**Agriculture and Forestry (*N* = 27)**	**Service Industries (*N* = 163)**	**Technology(*N* = 175)**	**Health and Welfare (*N* = 179)**	**Information and Communication Technologies (*N* = 32)**
Questions 50–56 deal with the connection between mathematics and your future career and studying mathematics. I will need mathematics in my future career.	***M***	3.80	4.23	4.07	3.99	4.12	4.35	3.88
	S.D.	0.917	0.847	0.675	0.786	0.797	0.823	0.833
Mathematics is easy for me.	***M***	3.00	3.16	3.41	3.07	3.17	2.93	3.19
	S.D.	1.184	0.987	0.888	1.150	0.954	1.081	1.030
I want to study mathematics more than the jobs of my future career would require.	***M***	2.36	2.78	2.44	2.38	2.68	2.52	2.63
	S.D.	1.106	1.078	1.155	1.061	0.989	1.056	1.129
It is enough for me that the stories, examples and tasks involved in studying	***M***	3.03	3.13	3.11	3.03	3.07	2.84	3.31

mathematics are related to everyday life and work tasks in someone else's field, they do not have to be related to my own field.	***S.D.***	1.019	0.856	0.847	0.899	0.897	0.976	0.998
It is important that the mathematics taught in vocational training (stories, examples, and assignments) is closely related to the work assignments in my own field.	***M***	3.52	3.40	3.59	3.46	3.61	3.73	3.31
	S.D.	0.996	0.844	0.694	0.877	0.802	0.820	0.859
Studying mathematics online sounds like an interesting opportunity.	***M***	2.87	3.49	2.96	3.17	3.17	3.21	3.03
	S.D.	1.263	0.850	1.055	1.022	0.954	1.053	0.933
I want to study mathematics in an on-the-job training place rather than a classroom.	***M***	2.50	2.84	3.44	2.77	2.89	2.79	2.91
	S.D.	1.122	0.850	1.050	1.086	0.950	0.966	1.058
I need support in studying mathematics (e.g., from a teacher, a classmate, parents).	***M***	3.00	2.79	2.63	3.03	2.87	3.31	2.56
	S.D.	1.217	1.012	1.043	1.234	1.083	1.176	1.162

APPENDIX F

Perceptions of students entering vocational education ($N = 824$) concerning studying mathematics, numbers and percentages of responses to "completely disagree" or "disagree" (A), "neither agree nor disagree" (B) and "largely agree" or "completely agree" (C).

Claim		**Humanities and Arts ($N = 128$)**	**Business, Administration and Law ($N = 120$)**	**Agriculture and Forestry ($N = 27$)**	**Service Industries ($N = 163$)**	**Technology($N = 175$)**	**Health and Welfare ($N = 179$)**	**Information and Communication Technologies ($N = 32$)**
Questions 50–56 deal with the connection between mathematics and your future career and studying mathematics. I will need mathematics in my future career.	**A**	12 (9.4%)	2 (1.7%)	0 (0.0%)	4 (2.5%)	2 (1.1%)	4 (2.2%)	1 (3.1%)
	B	33 (25.8%)	23 (19.2%)	5 (18.5%)	33 (20.2%)	37 (21.1%)	25 (14.0%)	10 (31.3%)
	C	83 (64.8%)	95 (79.2%)	22 (81.5%)	126 (77.3%)	136 (77.7%)	150 (83.8%)	21 (65.6%)
Mathematics is easy for me.	**A**	46 (35.9%)	26 (21.7%)	3 (11.1%)	49 (30.1%)	36 (20.6%)	61 (34.1%)	6 (18.8%)

	B	31 (24.2%)	52 (43.3%)	14 (51.9%)	56 (34.4%)	72 (41.1%)	63 (35.2%)	13 (40.6%)
	C	51 (39.8%)	42 (35.0%)	10 (37.0%)	58 (35.6%)	67 (38.3%)	55 (30.7%)	13 (40.6%)
I want to study mathematics more than the jobs of my future career would require.	**A**	71 (55.5%)	43 (35.8%)	13 (48.1%)	89 (54.6%)	60 (34.3%)	94 (52.5%)	14 (43.8%)
	B	40 (31.3%)	51 (42.5%)	8 (29.6%)	53 (32.5%)	86 (49.1%)	53 (29.6%)	12 (37.5%)
	C	17 (13.3%)	26 (21.7%)	6 (22.2%)	21 (12.9%)	29 (16.6%)	32 (17.9%)	6 (18.8%)
It is enough for me that the stories, examples and tasks involved in studying mathematics are related to everyday life and work tasks in someone else's field, they do not have to be related to my own field.	**A**	35 (27.3%)	20 (16.7%)	4 (14.8%)	34 (20.9%)	30 (17.1%)	57 (31.8%)	4 (12.5%)
	B	53 (41.4%)	64 (53.3%)	17 (63.0%)	86 (52.8%)	94 (53.7%)	86 (48.0%)	16 (50.0%)
	C	40 (31.3%)	36 (30.0%)	6 (22.2%)	43 (26.4%)	51 (29.1%)	36 (20.1%)	12 (37.5%)
It is important that the mathematics taught in vocational training (stories, examples, and assignments) is closely related to the work assignments in my own field.	**A**	14 (10.9%)	13 (10.8%)	0 (0.0%)	17 (10.4%)	5 (2.9%)	8 (4.5%)	3 (9.4%)
	B	49 (38.3%)	58 (48.3%)	14 (51.9%)	67 (41.1%)	86 (49.1%)	55 (30.7%)	18 (56.3%)
	C	65 (50.8%)	49 (40.8%)	13 (48.1%)	79 (48.5%)	84 (48.0%)	116 (64.8%)	11 (34.4%)
Studying mathematics online sounds like an interesting opportunity.	**A**	44 (34.4%)	10 (8.3%)	7 (25.9%)	34 (20.9%)	33 (18.9%)	40 (22.3%)	7 (21.9%)
	B	37 (28.9%)	53 (44.2%)	10 (37.0%)	67 (41.1%)	81 (46.3%)	61 (34.1%)	17 (53.1%)
	C	47 (36.7%)	57 (47.5%)	10 (37.0%)	62 (38.0%)	61 (34.9%)	78 (43.6%)	8 (25.0%)
I want to study mathematics in an on-the-job training place rather than a classroom.	**A**	59 (46.1%)	39 (32.5%)	3 (11.1%)	63 (38.7%)	47 (26.9%)	62 (34.6%)	8 (25.0%)
	B	50 (39.1%)	61 (50.8%)	14 (51.9%)	59 (36.2%)	94 (53.7%)	80 (44.7%)	18 (56.3%)
	C	19 (14.8%)	20 (16.7%)	10 (37.0%)	41 (25.2%)	34 (19.4%)	37 (20.7%)	6 (18.8%)
I need support in studying mathematics (e.g., from a teacher, a classmate, parents).	**A**	41 (32.0%)	43 (35.8%)	12 (44.4%)	52 (31.9%)	57 (32.6%)	44 (24.6%)	15 (46.9%)
	B	45 (35.2%)	53 (44.2%)	10 (37.0%)	48 (29.4%)	76 (43.4%)	51 (28.5%)	11 (34.4%)
	C	42 (32.8%)	24 (20.0%)	5 (18.5%)	63 (38.7%)	42 (24.0%)	84 (46.9%)	6 (18.8%)

APPENDIX G

Perceptions of students entering vocational education (N = 824) concerning mathematics, pairwise comparisons using the Kruskal-Wallis test.

Claim	Pairwise comparisons using the Kruskal-Wallis test	
	Fields and their mean ranks	***p*-value (Adj. Sig.)**
Questions 50–56 deal with the connection between mathematics and your future career and studying mathematics. I will need mathematics in my future career.	Humanities and Arts (337.57) - Business, Administration and Law (451.28)	0.001
	Humanities and Arts (337.57) - Health and Welfare (484.34)	0.000
	Information and Communication Technologies (347.80) - Health and Welfare (484.34)	0.030
	Service Industries (377.77) - Health and Welfare (484.34)	0.000
Mathematics is easy for me.	There were no statistically significant pairwise comparisons (p = 0.211)	
I want to study mathematics more than the jobs of my future career would require.	Humanities and Arts (370.19) - Business, Administration and Law (463.75)	0.027
	Service Industries (376.02) - Business, Administration and Law (463.75)	0.030
It is enough for me that the stories, examples and tasks involved in studying mathematics are related to everyday life and work tasks in someone else's field, they do not have to be related to my own field.	There were no statistically significant pairwise comparisons (even though p = 0.028)	
It is important that the mathematics taught in vocational training (stories, examples, and assignments) is closely related to the work assignments in my own field.	Business, Administration and Law (368.53) - Health and Welfare (466.49)	0.004
	Service Industries (392.91) - Health and Welfare (466.49)	0.047
Studying mathematics online sounds like an interesting opportunity.	Humanities and Arts (364.39) - Business, Administration and Law (477.11)	0.002
I want to study mathematics in an on-the-job training place rather than a classroom.	Humanities and Arts (348.63) - Technology (435.01)	0.020
	Humanities and Arts (348.63) - Agriculture and Forestry (544.13)	0.001
I need support in studying mathematics (e.g., from a teacher, a classmate, parents).	Information and Communication Technologies (328.59) - Health and Welfare (477.21)	0.016
	Business, Administration and Law (370.62) - Health and Welfare (477.21)	0.002
	Technology (388.01) - Health and Welfare (477.21)	0.006

