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Research Article

Vocational school students' use and opinions of voluntary-based online learning solutions presented in a mathematics course

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ABSTRACT

This article focuses on the use made by Finnish vocational upper secondary students, including their opinions, with regard to the voluntary-based aspects and activities of a compulsory mathematics online course. In particular, the study investigated whether the vocational field affects students' views and actions. There were altogether 313 students from six vocational fields participating in this study, but the number of students who responded to the feedback questionnaires related to the different opportunities and activities varied. Of the opportunities offered, the repetition opportunity was the most used and the most useful from the students' point of view. Almost 90% of the respondents ended up, either voluntarily or under guidance, taking advantage of the repetition option. The education video was watched by almost 60% of the students responding to the questions related to the video. Students had a positive attitude towards the effects used in the educational video, the length of the video, and the level of explanation of theory. Approximately half of the respondents who were offered an additional practice opportunity took advantage of this, and the opportunity was seen as quite useful. There were only minor, if any, statistically significant differences between the vocational fields regarding the use of the opportunities offered and the opinions related to them. This research will assist in developing online teaching of mathematics at vocational upper secondary level and will also offer guidelines for the development of online education more generally.

Keywords: educational technology, mathematics education, online learning, vocational upper secondary education

The main results of the article have been published in the dissertation summary in spring 2024.

INTRODUCTION

This research is related to the goals of the reform of vocational upper secondary education in Finland in 2018, which aimed to increase such things as work-based learning and individual study paths (Finnish Government, 2017). The Act on Vocational Education and Training (2017) legislated that an education provider must recognize a student's possible previous competence and, together with the student, draw up a personal competence development plan for the student starting vocational education and training. In the reform, attention was paid to the competence-based nature of education and the flexibility of learning environments (Finnish Government, 2017). Digital learning environments were expected to play a significant role in the implementation of the reform, for example in terms of constructing individual study paths (Koramo et al., 2018).

The intention of this research project has been to respond to the goals of the reform by developing an asynchronous compulsory online course in mathematics that the student could at least partially complete while simultaneously learning at the workplace. In addition, the mathematics online course is intended to ensure that the course genuinely takes into account the students' individual starting levels, needs and aims as efficiently as possible.

Since the development of an online course should start with getting to know the target group (e.g., Baldwin & Ching, 2019), the views of students starting vocational education concerning their own basic information and communication technologies (ICT) skills (Suominen et al., 2021) and online learning and studying mathematics (Suominen et al., 2022) had been investigated previously. This article focuses primarily on discovering how students from different vocational fields used and evaluated some of the activities contained in the pilot version of the mathematics online course, especially the opportunity for repetition, the educational video, and the possibility of additional practice.

Basis on the qualification requirements, the compulsory targeted learning outcomes and assessment criteria for mathematics contained several mentions of the student's own vocational field and working life (Finnish National Agency for Education, 2017). Previous studies have also found that integrating mathematics into the vocational experience has a positive effect on students' attitudes to learning mathematics (Dalby & Noyes, 2015) and increases the use of peer learning (Frejd & Muhrman, 2020). For these reasons it was important that at least some of the materials of the online mathematics course under construction should be related to the student's own vocational field. Since at least some materials were to be field-specific, it was important to ascertain how students from different vocational fields use and relate to different online learning solutions.

In this study, the main form of learning is *asynchronous online learning*, i.e., online learning that is independent of time and place. Students acquire and demonstrate their skills in an online course produced in a Moodle learning environment. It is possible for the students to start this mathematics online course any time and progress in the course from start to finish at their own pace. At the beginning of the online course, all the instructions relevant to the completion of the course are presented, including technical instructions related to the use of the online learning environment and its activities. As a rule, the students acquire competence in Lesson activities and demonstrate competence in Quiz activities. The students' interaction with the contents of the online course is promoted by using plenty of immediate feedback, narratives, visuals, and versatile activity types. In competence demonstration assignments, where the students apply mathematical basic skills in situations of their own vocational field, the students receive written personal feedback from the online teacher. The students can monitor their progress in the online course from the Completion Progress block and they can contact the online teacher for example by calling or sending chat messages with the learning environment. Besides, the students can go to complete online studies on-site at the educational institution's workshops, where support can be obtained from coaches. The online course of this study has also been used in a model where students completed online courses at specific times at the educational institution and were able to receive support from the coach.

LITERATURE REVIEW

In the following sections attention is paid to the impacts of voluntary activities. In addition, an overview is made of vocational education students' attitudes and also the attitudes generally associated with them regarding the study of theoretical subjects such as mathematics. Finally, using the results of previous studies, attention is paid to how video-based learning can be used in functional and effective ways.

Voluntary-based Online Learning Activities

Online courses facilitate flexible learning experiences, but they also require the skills of planning, managing and assessing one's own learning and performance. Previous studies show that self-regulated learning strategies have a positive effect on success in online courses (Bradley et al., 2017; Broadbent & Poon, 2015), whereas students with poor self-regulation skills are more likely to drop out of online courses (Lee et al., 2013).

The use of voluntary-based activities can be an indication of students' taking control of their learning process (Ruipérez-Valiente et al., 2016). The voluntary-based learning activities can be passive, such as watching videos or reading texts, or interactive, such as solving problems or answering questions (Koedinger et al., 2015; Ruipérez-Valiente et al., 2016). With respect to the benefits of the use of voluntary-based activities, the study by Ruipérez-Valiente et al. (2016) of online general chemistry courses showed that when students used the optional goal-setting tool included in the course platform, more than half of the goals were achieved. In the study by Kizilcec et al. (2017) focusing on self-regulated learning strategies in the context of massive online open courses' (MOOCs), goal-setting and strategic planning predicted students who would achieve their personal goals. Feldman-Maggor et al. (2022) found that submission of an optional assignment was an important predictor of course completion in open university online chemistry courses. Analysing the use of voluntary-based activities can be a beneficial tool for teachers for measuring student engagement and predicting students' success in online courses (Feldman-Maggor et al., 2022). The use of voluntary-based activities can also be used in examining students' learning patterns and in developing educational activities that promote self-regulated learning skills (Feldman-Maggor et al., 2022), which are arguably useful in the students' further education and career paths (Hsu et al., 2022; Vosniadou, 2020).

Vocational Education Students' Attitudes to Theoretical Subjects

A cliché suggests vocational students to be more interested in practice rather than theory, according to the literature review by Rosvall et al. (2017). However, previous research (e.g., Ferm, 2021; Rosvall et al., 2017) has shown this issue to be more complicated. For example, Ferm (2021) states that vocational students are active actors who make justified choices in order to construct their future careers. Moreover, it is indicated that the mathematics teaching methods used in vocational schools are chosen to be practical, which may strengthen students' perceptions of their being more practically oriented since they do not have opportunities to experience theory-oriented approaches (Rosvall et al., 2017).

Ferm (2021) studied vocational students' way of handling the distinction between theoretical and practical orientations, i.e., the academic/vocational divide, as referred to in the article. It was shown that students have three ways of addressing this division. First, students place a higher value on the practical knowledge rather than theoretical knowledge. Second, students reinforced this division by referring to school and work as two totally different contexts. Third, theoretical subjects were assigned value as important tools for the future. These findings suggest that students are well aware of the status hierarchy between theoretical- and practical fields and have specific methods of coping with it.

The amount of research focusing more strictly on vocational students' attitudes to mathematics is rather modest, as noted by Buabeng-Andoh (2019). His study repeated a finding familiar from other educational levels: students who felt competent in mathematics and who enjoyed it were those who had positive attitudes to the subject. In addition, the perceived relevance of mathematics correlated with positive attitudes. Surprisingly, any perceived difficulty and anxiety did not appear to affect students' attitudes towards mathematics. Vocational students have described mathematics as one of only a few theory-oriented subjects that would be useful for their future work in industry (Ferm, 2021).

Videos in Education

The scarcity of research related to vocational education in comparison to other school levels becomes evident whilst searching for previous studies concerning the use of videos in education. Thus, this section includes selected studies from other school levels.

Typically, using videos in education has been found to have positive effects on students' learning in higher education as shown in the systematic literature review by Noetel et al. (2021), supported by other studies (Ali, 2019; Forbes et al., 2016; Nabayra, 2022). However, 19% of the studies analysed in the review article by Noetel et al. (2021) have proven video-based instruction to be unhelpful for learning in the cases where other type of teaching (e.g. face-to-face lectures) is replaced with video. Besides, 31% of the studies analysed in the afore-mentioned review have shown the effects of replacing other teaching with video being negligible for learning. The last finding is supported by other studies (Brockfeld et al., 2018; Lang, 2016). These partially conflicting examples illustrate that the use of videos can be helpful or unhelpful for learning, depending on the context and implementation.

A review article related to using videos in nursing education states the use of videos being promising in terms of their effectiveness and efficiency even if some conflicting findings and concerns about the accuracy of videos related to nurses' clinical skills are presented (Forbes et al., 2016). Some studies have shown videos to be meaningful for students' motivation (Cattaneo, et al., 2019; Kinnari-Korpela, 2015) whilst others have reported the issue of attitudes and motivation to be a more complex issue (Lang, 2016; Sen, 2022).

Previous studies have given recommendations for implementing educational videos. For example, the report designed for vocational education gives separate multi-phased recommendations for using videos in teacher training, school-based training, and corporate training (Cattaneo et al., 2019). Without going to details, these recommendations include but are not limited to providing support and promoting interaction, practical elements such as choosing and designing videos, reducing cognitive load, and evaluating the results. In her review article, Brame (2016) highlighted three elements that are strongly connected to the previous ones – cognitive load, student engagement and active learning – whose consideration in the design and implementation of educational videos could help maximize the benefits of using educational videos in teaching biology. In order to manage cognitive load, increase students' commitment to the video and increase active learning based on the video, it was recommended to keep the videos brief (supported by Ali, 2019; Cattaneo et al., 2019; Guo et al., 2014; Santos-Mellado et al., 2017) and focused on learning objectives; to use audio and visual elements in the videos to convey the essential parts of the explanation; to use a conversational, enthusiastic style; to use, for example, guiding questions and interactive elements and to emphasize important ideas and concepts by *signaling* (Brame, 2016). Regarding signaling, for example, in the study made by Rodemer et al. (2022) *dynamic signals* meant "a sequential red dot" and *static signals* meant "permanent coloring of specific representational features". They found that non-graduate chemistry students benefited more from the dynamic signals of instructional videos than from static signals or no signals at all when watching a video containing complex chemical symbolic representations. As a result of the dynamic signals, the students were able to better focus on the relevant features of the presentation and their external cognitive load decreased (Rodemer et al., 2022).

RESEARCH QUESTIONS

The purpose of the present study is to discover how students from different vocational fields relate to different voluntary-based opportunities and activities in their online mathematics course. To find out how students used activities related to repetition, an educational video, and additional practice and also their opinions of them, the following research questions were formulated:

How do students completing the compulsory online mathematics course use and regard their voluntary-based

1. competence-related repetition opportunity?
2. educational video?
3. additional training opportunity?

Since the actual mathematics online course to be developed included the requirement that at least part of the theoretical sections, examples, and learning tasks of the course needed to be closely clinked with the student's own vocational field, all of the research questions have been looked at from the perspective of those various fields.

METHODOLOGY

Mathematics Pilot Course

The context of this study has been the pilot version of the compulsory online course in mathematics and in some of its prospects and activities. The course produced was the second of two compulsory mathematics online courses, i.e., part 2, at the educational institution participating in the study. Part 2 covered targeted learning outcomes related to equations and mathematical applications in the student's own vocational field.

The online course was produced in Moodle. Students who completed the course acquired competence during the lessons and then demonstrated their competence in assignments (exams) created by Quiz activity. The lessons included new content, examples, learning tasks, and instructions. The versatile learning tasks for which the student received immediate feedback did not affect their eventual course grade. Some of the lesson materials were grouped according to skill level, vocational field, need for repetition, need for additional practice, and further study wishes. For example, grouping according to skill level meant that if the student answered the learning task incorrectly, they received additional instructions and then an easier learning task.

A large part of the exams, i.e., exercises where competence could be demonstrated, were automatically evaluated. Various question types were used, e.g., short answer, multiple choice, matching and drag, and drop into text. The teacher-assessed assignments, which consisted of essays, were even more applied than auto-graded assignments. The course included visual instructions related to certain basic IT skills, such as sharing a OneDrive file that had been devised, for example, on the basis of the results of our previous study (Suominen et al., 2021). Student feedback focused on three entities: repetition opportunity, the educational video, and additional training opportunity, which in turn are the focus of the present article.

Repetition opportunity

Since the object of the research was part 2 of the compulsory mathematics course, the students commenced at very different starting levels. Some had recognition of previous competence based on their earlier studies, meaning their previous mathematics studies may have taken place a long time ago. Others had recently completed the part 1 of the compulsory mathematics in their online studies. The assumption was that the student should have certain starting skills when commencing the mathematics online course part 2, or student needed to be given an opportunity to repeat. Since vocational training in Finland is competence-based, it is not appropriate to force evidently competent students to repeat. Hence, repetition materials were produced for the first lesson of pilot course referred to as "Expression".

The "Expression" lesson started with the assignment of an introductory example. On the second page of the lesson, the student was instructed that this course required skills familiar from the first compulsory course, such as sign rules. The students were offered the opportunity either to directly repeat the sign rules or to first answer the tasks that would help them test whether there was a need for a repetition. If the student chose to undertake the repetition, they were offered theory, examples and learning tasks concerned with the sign rules of addition, multiplication and division. If the student continued directly to the tasks, they ended up testing these skills. If they proved that they had mastered the required skills, they could skip the whole repetition material, but if the required competence was not demonstrated, the student was directed to the repetition material. Eventually, all of the students ended up with the solution of the introductory example, for which they repeated and practised the formation of the expression, the order of calculations, and rounding the answer.

Having completed this initial stage of the lesson, the students were again offered the opportunity to repeat or test their previous knowledge of significant numbers and rounding rules. If the individual student chose to test their skills, they were offered five pages of tasks. If all of the tasks were completed correctly, all the repetition material could be skipped. If, however, some task was answered incorrectly, the student reverted to the repetition material to revise the necessary part. Finally, all students ended up with common material again.

Educational video

The educational video in the mathematics pilot course addressed expanding brackets and it was in a lesson headed “Polynomial”. Students were initially advised to examine an example related to expanding brackets, following which they were directed to the video with the instruction: “Now watch the video where the previous example is solved and explained step-by-step.” The word “video” provided a link to a teacher-produced screencast video, i.e., a narrated PowerPoint converted into video and uploaded to YouTube.

The example was prepared using Microsoft PowerPoint. In both the text version and the video, arrows, text boxes and colours (blue, yellow, and purple) were used to aid understanding. The video was exactly three minutes long. Students were able to progress in the lesson without needing to watch the screencast video by clicking the button “Next” on the slide. Following the video, they were offered two examples and a learning task related to calculating the value of the expression.

Additional training opportunity

The concluding part of the course “Applications in your own vocational field” consisted of two lessons concerning working life applications. The teaching materials were divided into different paths according to vocational field, asking the student to select one of the paths: “Practical nurse”, “Technology, agriculture, and forestry”, or “Other vocational fields”.

At the end of the first lesson related to working life applications, additional voluntary exercises were offered to the students who had chosen the option “Other vocational fields”. Before doing the voluntary exercises, the student could choose whether to do the practice tasks concerning percentage calculations or to move directly to the evaluated task. In the second lesson related to working life applications, additional voluntary exercises were offered to those choosing the option “Technology, agriculture, and forestry”. Before these voluntary exercises, students could choose whether they would undertake further practice tasks related to the basic percentage calculations or move on to studying value added tax. For practical nurses taking the mathematics pilot online course were not offered additional basic percentage calculation exercises in either lesson but in both lessons were offered a clear set of applications in their own field: medicine calculation.

Data Collection Methods

The online mathematics course included four questionnaires. The first consisted of demographic factors. In the first questionnaire, students were informed that the course was a part of dissertation research. In order for the student to progress technically in the course, it was necessary for the questionnaire to be answered, but the student could refuse to participate in the research by contacting the author of the research.

The second questionnaire focused on the repetition opportunity and the third on the educational video. For some of the vocational fields, additional voluntary exercises were made available during the course. The fourth questionnaire inquired about the students’ opinion of voluntary additional training. The fourth questionnaire also asked other issues relevant to the development of the course, such as the positive aspects of the course or how it could be improved, although these responses will not be focused on here.

The development of the questionnaires for the pilot course was strongly guided by a practical need: It was necessary to find out whether the students took advantage of voluntary-based opportunities or not and how useful they saw these opportunities – the results would give indications whether it is worth using the resource to produce voluntary activities when preparing online courses. There were no ready-made, validated questionnaires that met the needs of our research, so we ended up creating clear and unambiguous questionnaires ourselves. In the questions related to the utilization of the activities and the appropriate length of the video, the answer options were “Yes” and “No”. In the 5-point Likert questions related to the usefulness of the voluntary activities and the features of the educational video, the options were “useless”, “rather useless”, “neither useless nor useful”, “fairly useful” and “useful”. In addition, the students were asked about their opinion about the explanation level of the video. In this question the options were “too detailed”, “appropriate” and “too general”.

Table 1. Age distribution of students participating in the pilot course under study

Age	Frequency	Percentage (%)	Cumulative percentage (%)
15-19	116	37.1	37.1
20-24	36	11.5	48.6
25-29	38	12.1	60.7
30-34	27	8.6	69.3
35-39	17	5.4	74.7
40-44	18	5.8	80.5
45-49	24	7.7	88.2
50-54	26	8.3	96.5
55-59	11	3.5	100
Total	313	100	

Reliability and validity of questionnaires were not measured by statistical means but rather with careful wording of the questionnaire items. Hence, the trustworthiness of the questionnaires was based on researcher's expertise with the topic at hand and familiarity with the sample group. As each item only addresses one theme, it was possible to make wording unambiguous. In the data analysis, there were no any signs of students misunderstanding any of the items.

Sample

The research cohort consisted of students who completed the mathematics compulsory online course part 2 or parts of it between March 2019 and November 2021. Some completed the entire course voluntarily and independently, independent of time and place. Some students had the recognition of prior learning based on previous studies and therefore completed only part of the course. Others, for their part, participated in a new pilot model for which online studies were carried out at their educational institution in accordance with the work schedule, supported by a coach. In this situation no alternative, traditional face-to-face teaching option was made available, a factor which may have affected students' online learning motivation.

Research permission was requested only for the responses provided by students at the educational institution involved in the study, and a separate online course was provided for the students at client educational institutions. However, several students from client educational institutions were ended up on the research course, and their responses were removed from the reports. After this, the total number of respondents to the background information questionnaire was $N = 349$ students. Thereafter, 33 students total were removed from the sample due to the following reasons: missing or evidently false information, inconsistencies in vocational fields, or declining from the research. Besides these, there were only three students from Information and Communication Technologies, so they ($N = 3$) were removed from the sample.

The age distribution of the students involved in the study ($N = 313$) is shown in **Table 1**. The most common educational background of the respondents was comprehensive school ($N = 204$, 65.2%), while the second most common was vocational upper secondary school ($N = 80$, 25.6%).

Of the students ($N = 313$), the number responding to the second questionnaire was $N = 298$, while the number responding to the third questionnaire was $N = 281$. Questionnaire four was completed by 269 students, but the number of students for whom the questions related to the additional exercises pertaining to, was $N = 170$. The number of respondents and the percentages of females and males completing the questionnaires in the various vocational fields are presented in **Table 2**.

Data Analysis Methods

The research data were analysed using quantitative methods. IBM SPSS Statistics (version 27) software was used to analyse the data. For questions requiring answer of either "Yes" or "No", the numbers and percentages of students who chose the different options were determined initially for the whole cohort and then according to their vocational field. Subsequently, when the conditions were met, a Chi-square test was performed in order to discover whether there was a statistical dependence between the vocational field and the students' responses. If the conditions of the Chi-square test could not be met, the Fisher-Freeman-Halton Exact test was used instead. If the connection between the variables was statistically significant ($p < 0.05$), then the significant standardized residuals (i.e. values > 1.96 or < -1.96) from the contingency table were looked at, as prescribed by Field (2018). Finally, the effect size measurement, Cramér's V, was calculated.

Table 2. Number of respondents and percentage of females and males completing questionnaires. Questionnaire Q1 dealt with demographic factors, Q2 with repetition opportunity, Q3 with educational video, and Q4 with additional training opportunity.

Vocational field	Number of respondents and percentage of females and males			
	Q1	Q2	Q3	Q4
Agriculture and Forestry (Agr.)	26 (84.6%-15.4%)	25 (84.0%-16.0%)	23 (82.6%-17.4%)	24 (83.3%-16.7%)
Business, Administration and Law (Bus.)	39 (71.8%-28.2%)	36 (72.2%-27.8%)	32 (75.0%-25.0%)	35 (74.3%-25.7%)
Health and Welfare (Health.)	125 (91.2%-8.8%)	119 (91.6%-8.4%)	116 (92.2%-7.8%)	12 (100%-0.0%)
Humanities and Arts (Hum.)	17 (64.7%- 35.3%)	17 (64.7%-35.3%)	15 (66.7%-33.3%)	15 (66.7%-33.3%)
Service Industries (Serv.)	41 (61.0%-39.0%)	39 (59.0%-41.0%)	37 (62.2%-37.8%)	36 (63.9%-36.1%)
Technology (Techn.)	65 (18.5%-81.5%)	62 (19.4%-80.6%)	58 (19.0%-81.0%)	48 (20.8%-79.2%)

Table 3. "Yes" and "No" responses by vocational field related to the voluntary repetition option of students completing pilot course (*N* = 298), numbers and percentages

Question		Hum. (*N* = 17)	Bus. (*N* = 36)	Agr. (*N* = 25)	Serv. (*N* = 39)	Techn. (*N* = 62)	Health. (*N* = 119)
Did you take advantage of the voluntary repetition opportunity?	Yes	11 (64.7%)	26 (72.2%)	19 (76.0%)	30 (76.9%)	42 (67.7%)	87 (73.1%)
	No	6 (35.3%)	10 (27.8%)	6 (24.0%)	9 (23.1%)	20 (32.3%)	32 (26.9%)

Table 4. "Yes" and "No" responses by vocational field related to receiving repetition materials via practise tasks as made by students completing the pilot course (*N* = 83)

Question		Hum. (*N* = 6)	Bus. (*N* = 10)	Agr. (*N* = 6)	Serv. (*N* = 9)	Techn. (*N* = 20)	Health. (*N* = 32)
Did you receive the repetition materials via the practise tasks after all?	Yes	5 (83.3%)	8 (80.0%)	3 (50.0%)	3 (33.3%)	8 (40.0%)	18 (56.3%)
	No	1 (16.7%)	2 (20.0%)	3 (50.0%)	6 (66.7%)	12 (60.0%)	14 (43.8%)

Cohen's (1988) suggestions were followed in the evaluation of the effect size: $V = 0.10$ (small effect), $V = 0.30$ (medium effect), $V = 0.50$ (large effect). For Likert-scale questions averages, standard deviations and percentages of students who chose different options were calculated. A Kruskal-Wallis test was then performed in order to find whether there was a statistical dependence between the students' vocational fields and their opinions. When the p-value of the test was lower than 0.05, the adjusted p-values for pairwise comparisons were examined and the effect sizes r for the pairwise tests were calculated. When reporting the results of the Kruskal-Wallis test and in calculating effect sizes, Field's (2018) instructions were followed.

RESULTS

First, let us examine the responses to questionnaire Q2, which was concerned with the possibility of repetition. Of those who responded to "Did you take advantage of the voluntary repetition opportunity?" (*N* = 298), 72.1% answered "Yes". **Table 3** shows the distribution of responses based on vocational field. The vocational field-specific percentages of students who directly chose the voluntary repetition opportunity varied between 64.7% (Humanities and Arts) and 76.9% (Service Industries). A Chi-square test of independence showed that there was not a significant association between the vocational field and selecting the repetition opportunity voluntarily, $\chi^2(5) = 1.749$, $p = .883$.

Students not taking advantage of the voluntary repetition opportunity (*N* = 83) were asked "Did you receive the repetition materials via the practice tasks after all?" 54.2% of the respondents selected the option "Yes". **Table 4** shows the distribution of responses to the question based on the vocational field. A Fisher-Freeman-Halton exact test showed that there was not a significant association between the vocational field and

Table 5. Attitudes of students (N = 298) completing the pilot course to the usefulness of the repetition opportunity, means and standard deviations (1 = useless, 2 = rather useless, 3 = neither useless nor useful, 4 = fairly useful, 5 = useful)

Claim		Hum. (N = 17)	Bus. (N = 36)	Agr. (N = 25)	Serv. (N = 39)	Techn. (N = 62)	Health. (N = 119)
Rate the usefulness of such a repetition opportunity in lessons on a scale of 1-5.	M	4.18	4.39	4.08	4.36	3.90	4.14
	SD	0.951	0.838	0.909	0.743	0.882	1.044

Table 6. Attitudes of students (N = 298) completing the pilot course to usefulness of the repetition opportunity, numbers and percentages of responses to "useless" or "rather useless" (A), "neither useless nor useful" (B), and "fairly useful" or "useful" (C)

Claim		Hum. (N = 17)	Bus. (N = 36)	Agr. (N = 25)	Serv. (N = 39)	Techn. (N = 62)	Health. (N = 119)
Rate usefulness of such a repetition opportunity in lessons on a scale of 1-5.	A	1 (5.9%)	1 (2.8%)	0 (0.0%)	1 (2.6%)	3 (4.8%)	8 (6.7%)
	B	3 (17.6%)	5 (13.9%)	9 (36.0%)	3 (7.7%)	12 (19.4%)	15 (12.6%)
	C	13 (76.5%)	30 (83.3%)	16 (64.0%)	35 (89.7%)	47 (75.8%)	96 (80.7%)

receiving the repetition materials via the practice tasks (p = .163). When considering the students who voluntarily chose the revision opportunity and those who nevertheless received the repetition materials via the practice tasks revealed, it is noticed that 87.2% of the students who answered questionnaire 2 (N = 298) eventually used the repetition materials.

All students who responded to questionnaire 2 (N = 298) were asked, on a scale of 1-5, to evaluate the usefulness of such a repetition opportunity. The means and standard deviations are presented in **Table 5** and the percentages of respondents selecting the options "useless" or "rather useless", "neither useless nor useful" and "fairly useful" or "useful" in **Table 6**.

Based on the results, the students rated the repetition option as fairly useful, as the means (M = 3.90–4.36) and the percentages for the two best options (64.0%–89.7%) were quite high and the percentages for the two worst options (0.0%–6.7%) were low. Only the mean obtained for Technology fell below 4 and only the percentage of the two best options obtained for Agriculture and Forestry fell below 75%. When running the Kruskal-Wallis test, it was found that the opinions expressed were significantly affected by the vocational field $H(5)$ = 11.767, p = 0.038. However, pairwise comparisons showed that there were no significant differences between vocational fields in the opinions. Only the comparison between the fields of Technology and Business, and Administration and Law (p = 0.053, r = 0.53) came rather close to being statistically significant.

Next, let us consider the responses to questionnaire Q3, which addressed the educational video that was offered. Of all those students who responded the question "Did you watch the video?" (N = 281), 59.8% selected "Yes". **Table 7** shows the distribution of responses based on vocational field. Of the Service Industries respondents, a clear majority (81.1%) watched the video, while for those in Agriculture and Forestry the smallest proportion (43.5%) watched the video. A Chi-square test of Independence showed that there was a significant association between vocational field and watching the video, $\chi^2(5)$ = 15.103, p = .010, V = .232. Effect size measures revealed that vocational field and utilization of video were weakly associated. When the standardized residuals, shown in **Table 7**, are examined, it can be seen that the educational video was not watched by significantly fewer Service Industries students than expected.

Students who had watched the video (N = 168) were asked several questions about the video. For instance, the students were asked to evaluate on a scale of one-five the usefulness of the educational video and effects, i.e., the arrows and textboxes, used in the video in aiding their understanding of the theory. The means and standard deviations are presented in **Table 8** and the percentages of respondents selecting the different options in **Table 9**. The means for the usefulness of the education video varied between M = 2.86–4.07, the percentages for the two worst options between 3.6%–28.6%, and for the two best options between 28.6%–75.0%.

Table 7. "Yes" and "No" responses by vocational field related to watching the educational video by students completing pilot course (N = 281), counts, percentages, expected counts and standardized residuals

Question			Hum. (N = 15)	Bus. (N = 32)	Agr. (N = 23)	Serv. (N = 37)	Techn. (N = 58)	Health. (N = 116)
Did you watch video?	Yes	Count and percentage	7 (46.7%)	18 (56.3%)	10 (43.5%)	30 (81.1%)	28 (48.3%)	75 (64.7%)
		Expected count	9.0	19.1	13.8	22.1	34.7	69.4
		Standard residual	-.7	-.3	-1.0	1.7	-1.1	.7
	No	Count and percentage	8 (53.3%)	14 (43.8%)	13 (56.5%)	7 (18.9%)	30 (51.7%)	41 (35.3%)
		Expected count	6.0	12.9	9.2	14.9	23.3	46.6
		Standard residual	.8	.3	1.2	-2.0	1.4	-.8

Table 8. Attitudes of students (N = 168) completing the pilot course to the usefulness of the educational video and effects used in video, means and standard deviations (1 = useless, 2 = rather useless, 3 = neither useless nor useful, 4 = fairly useful, 5 = useful)

Claim		Hum. (N = 7)	Bus. (N = 18)	Agr. (N = 10)	Serv. (N = 30)	Techn. (N = 28)	Health. (N = 75)
Rate the usefulness of the video in question for understanding the theory, on a scale of 1-5.	M	2.86	3.72	3.70	3.77	4.07	3.73
	SD	1.069	1.074	0.823	1.006	0.979	1.234
Arrows and text boxes were used in the video. Rate the usefulness of these effects for understanding the issue, on a scale of 1-5.	M	4.00	3.89	4.10	4.00	4.04	3.97
	SD	0.577	0.832	0.876	0.947	0.693	1.013

Table 9. Attitudes of students (N = 168) completing the pilot course to the usefulness and effects of the educational video, numbers and percentages of responses to "useless" or "rather useless" (A), "neither useless nor useful" (B) and "fairly useful" or "useful" (C)

Claim		Hum. (N = 7)	Bus. (N = 18)	Agr. (N = 10)	Serv. (N = 30)	Techn. (N = 28)	Health. (N = 75)
Rate the usefulness of the video in question for understanding the theory, on a scale of 1-5.	A	2 (28.6%)	2 (11.1%)	1 (10.0%)	3 (10.0%)	1 (3.6%)	12 (16.0%)
	B	3 (42.9%)	4 (22.2%)	2 (20.0%)	7 (23.3%)	6 (21.4%)	15 (20.0%)
	C	2 (28.6%)	12 (66.7%)	7 (70.0%)	20 (66.7%)	21 (75.0%)	48 (64.0%)
Arrows and text boxes were used in the video. Rate the usefulness of these effects for understanding the issue, on a scale of 1-5.	A	0 (0.0%)	1 (5.6%)	0 (0.0%)	1 (3.3%)	0 (0.0%)	8 (10.7%)
	B	1 (14.3%)	4 (22.2%)	3 (30.0%)	7 (23.3%)	6 (21.4%)	9 (12.0%)
	C	6 (85.7%)	13 (72.2%)	7 (70.0%)	22 (73.3%)	22 (78.6%)	58 (77.3%)

Based on the means and percentages of the various options, Technology students considered the educational video to be the most useful and least useful by Humanities and Arts students. However, the Kruskal-Wallis test revealed that opinions of the usefulness of the video were not significantly affected by vocational field $H(5) = 7.345$, $p = 0.196$. Students clearly had a more positive attitude to the usefulness of the effects used in the video than to the usefulness of the video itself. The means for the usefulness of the arrows and text boxes used in the video varied between M = 3.89–4.10, while the percentages for the two worst options varied between 0.0%–10.7% and for the two best options between 70.0%–85.7%. Based on the percentages, attitudes to the effects was most positive in the Humanities and Arts. With respect to this claim there were no statistically significant differences between the vocational fields, with $H(5) = 0.698$, $p = 0.983$.

Table 10. "Yes" and "No" responses related to opinions of the length of the educational video by students completing the pilot course (N = 168), numbers and percentages

Question		Hum. (N = 7)	Bus. (N = 18)	Agr. (N = 10)	Serv. (N = 30)	Techn. (N = 28)	Health. (N = 75)
Was the length of the video appropriate?	Yes	6 (85.7%)	17 (94.4%)	9 (90.0%)	26 (86.7%)	25 (89.3%)	69 (92.0%)
	No	1 (14.3%)	1 (5.6%)	1 (10.0%)	4 (13.3%)	3 (10.7%)	6 (8.0%)

Table 11. Attitudes of students completing the course (N = 168) to the explanatory level of the educational video, in terms of numbers and percentages

Claim		Hum. (N = 7)	Bus. (N = 18)	Agr. (N = 10)	Serv. (N = 30)	Techn. (N = 28)	Health. (N = 75)
Choose the option that you think is closest to the explanatory level of the video. The theory was explained in the video	too detailed	0 (0.0%)	1 (5.6%)	1 (10.0%)	1 (3.3%)	2 (7.1%)	5 (6.7%)
	appropriate	6 (85.7%)	16 (88.9%)	8 (80.0%)	26 (86.7%)	24 (85.7%)	61 (81.3%)
	too general	1 (14.3%)	1 (5.6%)	1 (10.0%)	3 (10.0%)	2 (7.1%)	9 (12.0%)

Table 12. "Yes" and "No" responses by vocational field related to the voluntary additional training option given by students completing the pilot course (N = 170)

Question		Hum. (N = 15)	Bus. (N = 35)	Agr. (N = 24)	Serv. (N = 36)	Techn. (N = 48)	Health. (N = 12)
Did you do extra voluntary exercises?	Yes	7 (46.7%)	14 (40.0%)	12 (50.0%)	20 (55.6%)	20 (41.7%)	5 (41.7%)
	No	8 (53.3%)	21 (60.0%)	12 (50.0%)	16 (44.4%)	28 (58.3%)	7 (58.3%)

The students (N = 168) were asked whether the length of the video was appropriate. A clear majority, 90.5%, felt that the length of the video (three minutes) was appropriate. **Table 10** shows the distribution of responses to the question. The percentage of "Yes" responses varied between 85.7–94.4% for the different vocational fields. A Fisher-Freeman-Halton exact test showed that there was no significant relationship between the vocational field and experience with the appropriate length of the video (p = .860).

The students who had watched the video (N = 168) were also asked to rate the explanatory level of the video on a scale of "too detailed" / "appropriate" / "too general". 83.9% of the students choose the option "appropriate", 10.1% option "too general" and 6.0% option "too detailed". **Table 11** shows the distribution of responses to the question, based on the vocational field. Examination of the different vocational fields reveals that 80.0%–88.9% of the students felt that the theory was explained in the video in sufficient detail. A Fisher-Freeman-Halton exact test revealed that there was no significant relationship between vocational field and attitudes to the explanatory level (p = .993).

Finally, students' opinions of the voluntary additional training path offered were investigated. Additional training material that included percentage calculation exercises was available to students in all of the vocational fields except for practical nurse students. Students who answered the questionnaire Q4 and who did not represent practical nurses (N = 170) were asked if they used the voluntary additional training path. Just under half (45.9%) of those who answered the question related to additional training material, did extra practice tasks. **Table 12** shows the distribution of responses based on vocational field. The vocational field-specific percentages of the students who undertook extra voluntary exercises varied between 40.0% (Business, Administration and Law) and 55.6% (Service Industries). A Chi-square test of independence showed that there was no significant association between vocational field and undertaking extra practice tasks, $\chi^2(5) = 2.441$, p = .785.

Students who were offered a voluntary additional training opportunity were also asked to evaluate the usefulness of such an opportunity on a scale of one-five. Means and standard deviations are presented in **Table 13** and the percentages of respondents selecting the options "useless" or "rather useless", "neither useless nor useful" and "fairly useful" or "useful" in **Table 14**.

Table 13. Attitudes of students (*N* = 170) completing the pilot course to the usefulness of the voluntary additional training path, means and standard deviations (1 = useless, 2 = rather useless, 3 = neither useless nor useful, 4 = fairly useful, 5 = useful)

Claim		Hum. (*N* = 15)	Bus. (*N* = 35)	Agr. (*N* = 24)	Serv. (*N* = 36)	Techn. (*N* = 48)	Health. (*N* = 12)
Rate the usefulness of such a voluntary training opportunity in the lessons, on a scale of 1-5.	M	3.87	3.91	3.54	3.86	3.77	4.33
	SD	0.834	0.981	1.285	1.099	1.036	0.778

Table 14. Attitudes of students (*N* = 170) completing the pilot course to the usefulness of the voluntary additional training path, numbers and percentages of responses to "useless" or "rather useless" (A), "neither useless nor useful" (B) and "fairly useful" or "useful" (C)

Claim		Hum. (*N* = 15)	Bus. (*N* = 35)	Agr. (*N* = 24)	Serv. (*N* = 36)	Techn. (*N* = 48)	Health. (*N* = 12)
Rate the usefulness of such a voluntary training opportunity in the lessons, on a scale of 1-5.	A	0 (0.0%)	2 (5.7%)	4 (16.7%)	3 (8.3%)	3 (6.3%)	0 (0.0%)
	B	6 (40.0%)	12 (34.3%)	6 (25.0%)	9 (25.0%)	14 (29.2%)	2 (16.7%)
	C	9 (60.0%)	21 (60.0%)	14 (58.3%)	24 (66.7%)	31 (64.6%)	10 (83.3%)

The means for the usefulness of the voluntary training opportunity varied between *M* = 3.54–4.33, the percentages for the two worst options between 0.0%–16.7%, and for the two best options between 58.3%–83.3%. Based on the means and the percentages of the various options, the voluntary training opportunity was found to be most useful by Health and Welfare students and least useful by Agriculture and Forestry students. However, based on the results of Kruskal-Wallis test, it can be concluded that there are no statistically significant differences between the vocational fields in this claim, $H(5) = 4.080$, $p = 0.538$.

DISCUSSION

An investigation was undertaken in this study of vocational education students' use of and attitudes to certain possibilities and activities, i.e., the repetition possibility, the educational video and the possibility of additional training involved in the online mathematics course. Our attention was particularly focused on whether a particular vocational field would affect students' actions and opinions. The outcome of this study has helped in the development of online teaching especially in vocational upper secondary level mathematics.

Research question 1 was concerned with how students completing a compulsory online mathematics course used and also viewed the voluntary competence-based repetition opportunity. From the viewpoint of the requirement of competence-based and individual study paths in Finnish vocational education and training (Finnish Government, 2017), it was assumed that there could be a demand for the repetition opportunity and additional training materials. The results gathered in this study confirm this assumption. Almost nine out of ten students ended up using repetition materials, either voluntarily or eventually resorting to repetition through practice tasks. In addition, students also found repetition possibility quite useful when asked about their attitude concerning it. There were no statistically significant differences between the vocational fields in relation to voluntary repetition or ending up using repetition via the practice tasks, nor in opinions concerning the usefulness of the repetition option – repetition is popular and necessary, regardless of the students' vocational field.

The students' high need and positive attitude towards (voluntary) repetition is an important and interesting finding that leads to additional questions and ideas for further research. We are especially interested in finding out possible underlying reasons for these significantly positive attitudes: Could it be explained by students' freedom to choose, well-designed and functional online learning environment, or their maturity, as a majority of the students were adults who have learned the importance of mathematics for their lives?

Previously, it was found that although the experience of needing support for example from a teacher, a classmate or parents when studying mathematics was not remarkably common in any of the vocational fields, Health and Welfare students felt that they needed significantly more support in studying mathematics than did students in many other fields (Suominen et al., 2022). Gender may be one reason for the perceived need for support, since in our previous study 79.9% of Health and Welfare students were women (Suominen et al., 2022). In a Finnish national assessment of learning outcomes in 9th grade mathematics, girls considered their skills in mathematics to be significantly weaker than that of boys even though there were no gender differences in their actual competence (Metsämuuronen & Nousiainen, 2021). In the present study, the fields of Health and Welfare and Technology were again clearly traditionally gendered. However, there were no significant differences between the fields in the actual use of the repetition opportunity.

Future research could delve more into how the repetition opportunity effects on students' user experience and actual learning in online courses and if it is possible to promote effective learning with such course designs that enable students to recognize their skill gaps and spend more time and effort with the specific areas that they struggle with. When designing online learning environments, courses and materials, educators must be careful in recognizing the needs of support and monitor what kind of effect online approaches have on the development of mathematics *self-efficacy*. In the study of Zwart et al. (2020), nursing students' mathematics self-efficacy actually decreased after an intervention incorporating digital learning materials, which was believed to result from students' unfamiliarity of online learning activities and insufficiently communicated quality and completion criteria of the learning tasks, thereby causing too many demands and evoking negative emotions among the students.

Research question 2 concerned students' use and views with respect to the voluntary educational video and its features. Three out of five students who answered the questionnaire about the educational video had actually watched the video. In our prior study about vocational students' expectations of online learning (Suominen et al., 2022), verbal instructions, pictures and videos were the most favored ways to receiving online learning instructions. Video guides were especially preferred among the Humanities and Arts students. Surprisingly in the present study, Humanities and Arts students regarded the video as least useful. However, there were no statistically significant differences between the vocational fields, although the averages and percentages of different options between the different vocational fields varied greatly.

One of the reasons why the educational video was not considered particularly useful may be that the content of the video had already been presented with the help of two screenshots from the video on the previous pages of the lesson. The screenshots had already presented the example with considerable clarity and detail, and hence the video may not have added as much value. It should also be noted that after watching the video the students did not immediately respond to tasks related to the video but continued with the examples and the practice task related to next mathematical content. Subsequently, the students were asked for their opinion of the video and only then did they move on to demonstrate their knowledge in the exam tasks, which also tested the topic presented in the video. It might be valuable to discover whether students would consider the video more useful if they were able to perform activities related to the topic of the video immediately after seeing it and only then respond to the questionnaire concerned with the video. It would also be interesting in the future to study whether watching the video affects the extent to which the individual student succeeds in the related exam. Koedinger et al. (2015) found that devising additional activities led to improved learning, rather than watching additional videos or reading additional pages. From this perspective it would also be important that some activities were offered to be performed with each theoretical content in addition to the video or text.

As could be seen from the results, the students developed an obviously more positive attitude to the usefulness of the effects used in the video than to the usefulness of the video itself. There were no statistically significant differences between the vocational fields in students' opinions concerning the usefulness of the effects used in the video. In an earlier study, Rodemer et al. (2022) noticed that when dynamic signals were used in instructional videos, students benefited more than from static signals or when there were no signals at all. The students in each field in the present study also agreed that both the length of the video (three minutes) and the level of explanation of the theory were appropriate. This result supports the findings of previous studies (Ali, 2019; Brame, 2016; Guo et al., 2014; Santos-Mellado et al., 2017) that for educational purposes students preferred short videos. Our results provide additional support for the effective features previously found in educational videos.

Finally, with regard to research question 3 concerning students' use of and attitudes to an additional training opportunity, it can be observed that almost half (45.9%) of those who were offered additional training material and who responded to the question related to this material also undertook extra practice. This kind of additional practice opportunity was generally regarded as quite useful. There were no statistically significant differences between the vocational fields in the use of the additional training opportunity or in the opinions related to its usefulness. Previously, we found that new vocational school students generally did not want to study more mathematics than their future careers would require (Suominen et al., 2022). It would be interesting to know whether such a large proportion undertook additional exercises because they felt that they would need the percentage calculation skill in their own vocational field. Currently, Finnish vocational education qualification requirements (Finnish National Agency for Education, 2021) obligate all students to acquire and demonstrate the same mathematical competence, regardless of their vocational field. It has been emphasised that it would be more meaningful from the student's point of view if the calculation examples and tasks were more directly related to the student's own vocational field (Finnish National Agency for Education, 2022a, 2022b). However, there are not necessarily clear areas of mathematical application in relation to all vocational fields as far as the current mathematics competence goals are concerned. For this reason it would be valuable to discover how the use of additional exercises and materials is affected by the availability and topics of these kind of materials – students are likely to regard different contents as challenging or useful.

Analysing voluntary-based activities is one way to investigate students' self-regulation skills and their engagement in online courses, and this knowledge can then be used in developing the kind of educational activities that will encourage students to take greater responsibility for their own learning (Feldman-Maggor et al., 2022). Our ongoing research provides a good basis for future examination of various aspects of the self-regulating learning behaviour of vocational education students. Research into the self-regulation skills of students with different demographic characteristics and different vocational fields would help educators to recognize and meet individual learning needs. As self-regulation skills are crucial especially in self-paced online courses, it would also be worthwhile to investigate the kinds of course designs, tasks and materials, and modes of interaction that would support students struggling with self-regulation so that they can be helped to complete their courses successfully.

Our present study has shown that, depending on the opportunity or activity offered, even a majority of vocational students can take advantage of voluntary-based opportunities offered to them in the context of mathematics. This suggests that these students, regardless of their individual enthusiasm for mathematics, may well consider it valuable for their education and future careers – an issue already addressed in previous research (Ferm, 2021). Perhaps this division between theory- and practice-oriented subjects, unnecessary in the first place, should be abandoned once and for all.

CONCLUSION

Of the opportunities offered in the online course 2 of compulsory mathematics; repetition, educational video and additional practice, the one that from students' point of view was the most clearly used, the most necessary and the most useful was the repetition opportunity. The educational video was not considered strikingly useful, but the students had a positive attitude towards the means of illustration used in the teaching video. Slightly less than half of the respondents did additional exercises and such a voluntary training opportunity was seen as quite useful. It is worth noting that the vocational field had almost no statistical significance in how the students utilized the opportunities offered in the online course or what they thought about them.

Based on the results, it is worth enabling repetition in compulsory mathematics online courses in vocational upper secondary education. The biggest limitation of the study is that it does not include students from all vocational fields. In the future, it is also necessary to find out whether offering voluntary opportunities for online courses have an impact on students' learning outcomes.

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