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Factors Affecting Undergraduate Medical Science Students' Motivation to Study during the COVID-19 Pandemic

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Abstract: In the current study, we investigated the motivational status and underlying factors of the motivational changes among Japanese medical science students brought by the COVID-19 pandemic. Two groups of second-year undergraduate medical science students (training to become medical technologists and/or medical science researchers) participated in this study in the summers of 2020 and 2021 by writing essays describing how the pandemic had affected their motivation to study. A content analysis of the motivation status and underlying factors (both motivating and demotivating factors) was conducted before statistical analysis was used to investigate possible differences between the sexes and the two groups. In total, 73 essays were included in the analysis. The students had increased motivation to study in both groups (89% and 62%, respectively); however, in Group 2021, 19% of the students (all women) had decreased motivation. Among the underlying reasons behind the increased motivation, students showed a desire to help/save others, contribute to the development of medical science, increase knowledge, and disseminate correct information. The demotivating factors were largely linked to online learning and the negative emotions associated with lockdown. Our findings suggest that, for Japanese medical science students, the COVID-19 pandemic has been an overall motivating experience for our students. However, the prolonged pandemic and lockdown measures could attenuate this and be particularly disruptive for women.

Keywords: COVID-19; medical science; student motivation; education; undergraduate

1. Introduction

In Japan, the new academic year begins in April, with the blooming of the cherry blossoms symbolizing fresh starts and future promise. From spring 2020, however, in response to the SARS-CoV-2 2019 (COVID-19) pandemic, local and national officials enacted several tiers of social, educational, and commercial restrictions that forced universities and schools across Japan to rapidly adopt online modes of learning at great expense to the institutions and causing stress for teachers and students alike [1,2]. The somewhat rural location of our university allowed for the return of students to the campus in a limited capacity from October 2020. Since then, the university has employed a hybrid learning style, with a combination of online and in-person classes, while maintaining measures such as mask wearing and social distancing. However, the impact of this paradigm shift in education has been particularly disruptive for the students of our medical faculty (clinical medicine, nursing, and medical science) for whom an essential part of their education is hands-on practical training such as clinical experience and experiments.

The profoundly negative impact of the pandemic on medical education has been globally reported and is reflected in studies such as a report from Jordan that investigated

the effect of distance learning on medical education and showed high levels of dissatisfaction among the students [3]. In a study of second-year medical students from the US, Shahrvini et al. found that about half of the students felt unprepared for their clinical clerkships and for taking the United States Medical Licensing Examination [4]. Harries et al., in their large cross-sectional study of six medical school in the United States, for example, reported that 74.7% of the respondents to their survey felt that the pandemic had disrupted their medical education significantly [5]. A nationwide study of 49 medical schools in Indonesia reported on how the pandemic had not only had devastating effects on medical student education but also on mental health through fear of infection, lost educational/training opportunities, and increased financial burdens [6]. Similarly, at the height of the lockdown period in Japan, when the students were studying online only, we were unable to provide some vital aspects of medical science education, such as hands-on laboratory experiments, which cannot be adequately experienced through online-only instruction. Furthermore, student life changed drastically with social distancing and lockdown measures forcing the closure of all extra-curricular activities, such as sports and music clubs, and the events that make university life fun. Thus, given the limitations of online learning and this additive lack of social interactions, we were concerned about our students' motivation to study. However, while there is a growing body of literature on the impact of COVID-19 on medical education, there is a paucity of studies investigating education for medical scientists or laboratory technologists.

The effect of constant media (traditional and social) highlighting the role of medical technology in the diagnosis and treatment of COVID-19 (e.g., PCR testing, blood tests for admitted patients, etc.) may have increased the profile of medicine in the public mind. In a previous study, we found medical students to be highly instrumentally and vocationally motivated, meaning that their motivation to study was largely based on its perceived usefulness for their future success in their chosen profession [7]. Hypothesizing that a similar vocational drive undergirds medical science students' motivation to study, we wondered whether the pandemic might have some positive impacts on our students' perceptions of their chosen career and whether it might have a subsequent effect on their motivation or whether they felt the negative effects of online study, social isolation, and anxiety, as reported in most studies dealing with COVID-19 and education. Regarding medical education, motivation is, as Pelaccia and Viau (2016) stated "a major determinant of the quality of learning and success, the lack of which may well explain why teachers sometimes observe medical students who are discouraged, have lost interest or abandon their studies, with a feeling of powerlessness or resignation" [8]. For medical science students, who, like medical students, are pursuing a professional degree, it requires a consistently high level of motivation to complete their requisite licensing requirements; therefore, we were keen to monitor and understand the effects of the pandemic on our students' education.

To gain some insight into this, we gathered data from our medical science students in the summer of 2020, four months after the start of the lockdown, and in the summer of 2021, using an English essay-writing activity. The findings presented in this study are derived from a content analysis of the student essays, which explored the questions of (a) how the pandemic has affected medical science students' motivation for studying and (b) the underlying factors behind that motivational change. We then further sought to explore (c) whether learning motivation and motivating factors varied significantly by sex. Finally, we detail (d) whether the length of time since the start of the pandemic (4 months vs. 16 months) had any significant impact on the above. The preliminary findings from this study were presented at the 24th Japanese Society of Medical English Education (JASMEE) Academic Meeting in July 2021 and appear in the conference proceedings [9].

2. Materials and Methods

2.1. Study Design and Participants

This study was designed as a quantitative content analysis [10] involving the systematic coding, quantification, and analysis of factors relating to the participants' study motivation during the COVID-19 pandemic. The participants of this study were a convenience sample of second-year undergraduates studying on a four-year degree program in medical science at the University of Tsukuba, a national, research-focused university located in Tsukuba Science City, Japan. As second-year undergraduates, the students were 19 to 20 years of age at the time of the data collection, and all were Japanese nationals. The study involved two groups of 37 students (74 students total): Group 1, which matriculated before the pandemic in Spring 2019, and Group 2, which matriculated at the start of the lockdown period in Spring 2020. Of the 74 total respondents of the groups, 48 were women (64.8%). The medical science course prepares the students for careers as licensed medical technologists who will work in hospital diagnostic laboratories. From the third year, the program also offers the option to take a more research-focused course of study, taught in English, for those students who are interested in pursuing graduate studies in medical science and careers in research. The participating students were enrolled on a compulsory 10-week English-language certification course, which, due to the pandemic, was being taught online. Informed consent was received from each of the participating students, and explanations of the right to opt out at any time were given.

2.2. Data Collection

The data were collected through essay-writing assignments in the summers of 2020 (Group 2020) and 2021 (Group 2021) as part of the coursework for the mandatory English certification course. In 2020, the students in Group 2020 were just beginning the summer vacation following 1 term (15 weeks) of online classes whereas, in 2021, the students in Group 2021 had completed two terms of hybrid learning preceded by a term of purely online learning. In the assignment, the students were instructed to write an essay of at least 500 words describing how the COVID-19 pandemic made them feel as medical science students and how it had affected their motivation to study medical science. The students had to write their essays in Microsoft Word (Microsoft Corporation, Redmond, WA, USA) and had a two-week deadline to return their essays. The university's online course management system, Manaba (Asahi Net, Inc., Tokyo, Japan), was used to administer the essay-writing assignment. The essays formed part of the students' coursework and therefore added no extra burden to their time. In preparation for the content analysis, the essays were anonymized and given identification numbers, and a note was made to identify the sex of each participant.

2.3. Data Analyses

The essays were carefully examined by the lead researcher, who used content analysis techniques [10–13], firstly to assess student motivational status (increased/decreased motivation, no change, etc.) and secondly to identify any key statements that described the underlying factors that influenced motivational status. Patterns and similarities in the ideas expressed in these key statements across the essays were identified and categorized, and coding labels were assigned to each discrete motivational factor. The coding labels were further categorized as motivating and demotivating factors and were also identified as being specific to medical science or not. Assigning coding labels allowed for the quantification of the occurrences of these factors within the essays as a whole.

For verification, the anonymized essays were then independently coded by two other researchers. This process involved each researcher reading the essays and, using a spreadsheet that included a list of the coding labels and their explanations, noting first the motivational status and second all the appropriate codes for that student. A consensus between two or three of the researchers was used for verification of each student's motivational status and assigned codes. Krippendorff's alpha [14,15] was used to evaluate

the interrater reliability for the coding, and the calculations were performed in Microsoft Excel (Microsoft Corporation, Redmond, WA, USA), using the RealStatistics plug-in (Dr. Charles Zaiontz). The counts and frequencies (%) of each motivational status and code were calculated separately by sex for each group. The Chi-squared test, Fisher's exact test, and effect size (Cohen's d) were used to examine the differences between the code counts by sex and by group, and significance was defined as $p < 0.05$ and very strong significance as $p < 0.001$. Effect size was calculated by a power of 0.9, alpha error, and the sample size for each group. The categorization of the effect size was as standard: small, $d = 0.2$; medium, 0.3; and large, 0.8 [16]. SPSS version 27.0 (IBM Corporation, Tokyo, Japan) was used for these statistical analyses. The coding process was performed separately for both groups. Differences between the proportions of motivating factors and demotivating factors between each group and by sex were also examined. Furthermore, the proportions of the medical science-specific to the non-medical science-specific (i.e., general) coded statements were also compared between the two groups.

3. Results

3.1. Motivation Status

A total of 74 essays were returned. One essay from Group 2020 was excluded as it did not sufficiently address the question; thus, 73 essays were included in the analysis. The essays were read and separately coded by three researchers, and the Krippendorff's alpha scores indicated good interrater reliability for the motivation analysis (Group 2020 = 0.806, Group 2021 = 0.781) [10]. Regarding the effect of the COVID-19 pandemic on student motivation, Figure 1A–F shows the results of the analysis of the 73 essays, comparing the results by year (Figure 1A,C) and sex (Women, Figure 1B,E; Men, Figure 1C,F). In Group 2020, 31 of the 36 students gave clear responses about their motivational status; of those, a majority (89%) reported increased motivation and, while some reported no change (7%) or decreased then increased motivation (4%), none reported a decrease in their motivation to study (Figure 1A). The results were similar for both sexes, with 90% of women and 89% of men reporting increased motivation (Figure 1B,C).
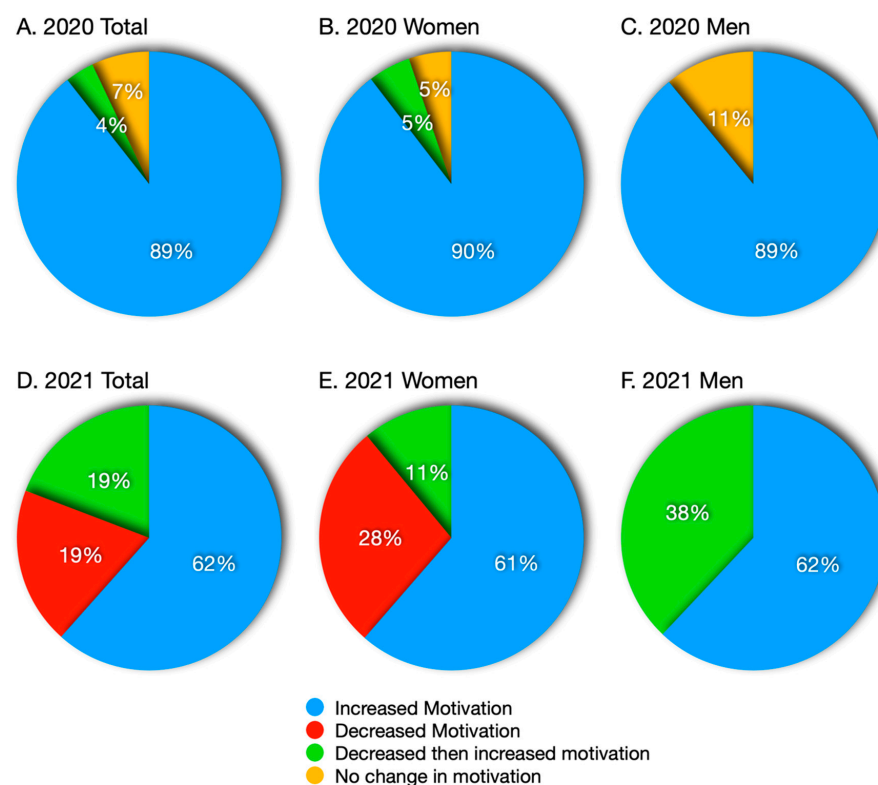

Figure 1. Changes in student motivation to study medical science during the COVID-19 pandemic.

In contrast, the number of students who reported increased motivation in Group 2021 reduced from 89% to 62% (Women, 61%; Men, 62%), as shown in Figure 1D. In Group 2021, 11% and 38% of the women and men, respectively, said that they experienced decreased then increased motivation (Figure 1E,F). In Group 2021, 28% of the women reported decreased motivation to study medical science, while in Group 2020 no students reported purely decreased motivation (Figure 1E).

3.2. Coding Analysis

The results of the coding analysis, which investigated the reasons (or factors) that underlie the students' changes in motivation are presented in full in Supplementary Tables S1 and S2 for Group 2020 and Supplementary Tables S3 and S4 for Group 2021. From the essays written by Group 2020, a consensus between the three researchers was reached for 154 statements that represented factors for motivation change. Of these 154 statements, 124 were distributed across 17 codes that represented motivating factors, and the remaining 30 statements were across 8 codes that represented demotivating factors. The codes for the motivating factors for Group 2020 (and the frequencies) were: *Save* (20), *Knowledge* (18), *Heroes* (17), *Truth* (13), *Mission* (12), *Contribute* (11), *Vaccine* (9), *Skills* (6), *Solution* (5), *Link* (4), *Research* (2), *Online Good* (2), *Vision* (1), *Success* (1), *Developing Countries* (1), *Challenges* (1), and *Career* (1). Those for the demotivating factors were: *Lonely* (4), *Discrimination* (3), *No Experiments* (3), *Online Bad* (3), *Government* (2), *Robbed* (2), *Screens* (2), and *Being Home* (1). For Group 2021, a consensus was found for a total of 119 statements, 81 of which were distributed across 18 codes representing motivating factors and 38 across 10 codes representing demotivating factors. The codes for the motivating factors for Group 2021 (and frequencies) were: *Save* (11), *Truth* (9), *Research* (9), *Value of Studies* (9), *Contribute* (7), *Communication* (6), *Protection* (5), *Link* (4), *Time* (3), *Media Good* (3), *Heroes* (3), *Innovation* (3), *In-person Classes* (2), *Shortage* (2), *Developing Countries* (2), *Online Good* (1), *Determined* (1), and *Vision* (1). Those for the demotivating factors were: *Online Bad* (10), *Robbed* (9), *Discrimination* (4), *Negative Emotions* (3), *Lack of Vision* (3), *Being Home* (3), *Lonely* (2), *No Experiments* (2), *Mask* (1), and *Media Bad* (1). To give a more detailed picture of the most frequently occurring factors, Tables 1 and 2 below show the motivating and demotivating factors with a higher frequency of responses (≥9) for Group 2020 and Group 2021, respectively. Included in Tables 1 and 2 and Supplementary Tables S1–S4 are short explanations and example sentences from the students' essays for each coding label. The tables also include counts and proportions (%) representing how many times that code occurred within the students' essays in total and by sex. Statistical comparisons between the frequency of the factors according to sex (*p* values and effect size) are also shown. In the tables, the codes have been divided into motivating and demotivating factors and arranged in descending order of frequency.

In total, 38 distinct codes were identified, of which 26 represented motivating factors and 12 represented demotivating factors. Statistical analysis of the coding statements exploring differences by sex found the code *Contribute* to be approaching significance (*p* = 0.073), with a medium to large effect size (*d* = 0.646; Table 1), and stronger significance and larger effect size were found for *Innovation* (*p* = 0.046; *d* = 0.673; Supplementary Table S3), with men being more impressed by advances and innovations in medical technology than women.

Figure 2A–F shows the proportion of coded statements expressing motivating factors to those expressing demotivating factors. In Group 2020, the proportion of motivational factors was, overall, 4 times that of the demotivating statements (Figure 2A) and was approximately the same for both the women (82%/18%; Figure 2B) and the men (80%/20%; Figure 2C). However, the proportion of motivating factors decreased from 81% in Group 2020 to 68% in Group 2021 (Figure 2A,D). The proportion of demotivating factors for the men decreased only by 1% (Figure 2C,F) but that for the women doubled, from 18% to 36% (Figure 2B,E).

Table 1. Coding analysis of Group 2020, motivating and demotivating factors with ≥9 responses.

	Coding Label	Explanation	Example Sentence	Women (N = 24) N (%)	Men (N = 12) N (%)	Total (N = 36) N (%)	Comparison by Sex *p* (Effect Size *d*)
Motivating Factors	*Save* [†]	Protect, help, benefit, save lives/people/the world (through medical science)	"I strongly felt that there is a need for medical science in society and that what I am learning will greatly help save lives".	12 (50)	8 (66.8)	20 (55.5)	0.343 (0.478)
	Knowledge [†]	Frustrated by lack of knowledge/want to increase knowledge/skills/deepen understanding, responsibility/opportunity to study	"A few days ago, I was asked about medical terms. For example, the PCR test and the coronavirus and so on. However, I couldn't answer these questions completely. I didn't have enough knowledge. I was so frustrated by my lack of knowledges despite studying medical science".	13 (54.1)	5 (41.6)	18 (50)	0.48 (0.41)
	Heroes [†]	Recognized the importance of/respect for/feel proud of medical scientists/health care workers, heroes	"I believe that medical scientists will be heroes which eradicate COVID19 to protect people all over the world".	12 (50)	5 (41.6)	17 (47.2)	0.732 (0.288)
	Truth [†]	Importance of having/collecting/disseminating correct information/knowledge	"We can save the world by getting the right information out there. With this COVID19 pandemic, there was a lot of information about the COVID19 flying around. People were confused as to which was the correct information. By disseminating the right information, we can prevent the spread of infection".	9 (37.5)	4 (33.3)	13 (36.1)	0.553 (0.385)
	Mission [†]	Pandemic made me think about life/medicine/medical science/gave a sense of mission, responsibility	"COVID19 steals our daily life and this can't be ignored. Many people want the solution that protects themselves. Personally, in this situation, I feel that I have to solve this problem like the mission".	10 (41.6)	2 (16.6)	12 (33.3)	0.13 (0.595)
	Contribute [†]	Contribute to/play my part in/the development of medicine, medical science/improve COVID testing	"I think I should contribute to medical science as a medical science student in the future. Moreover, I especially want to contribute to making a new medicine in the future".	5 (20.8)	6 (50)	11 (30.5)	0.073 * (0.646)
	Vaccine [†]	No vaccine/cure has been found/want to create a vaccine/cure	"If I study medical science, I will be able to develop a cure or a vaccine as a Medical scientist".	6 (25)	3 (25)	9 (25)	0.61 (0.358)
Demotivating Factors	*Negative Emotions*	I feel anxious/sad/worried/fearful/scared/danger/helpless/stressed	"The spread of COVID19 has increased my psychological and physical stress".	8 (33.3)	2 (16.6)	10 (27.7)	0.35 (0.47)

[†] Indicates medical science-specific coding labels. * Indicates statistically significant *p*-values.

Table 2. Coding analysis of Group 2021, motivating and demotivating factors with ≥9 responses.

	Coding Label	Explanation	Example Sentence	Women (N = 25) N (%)	Men (N = 12) N (%)	Total (N = 37) N (%)	Comparison by Sex *p* (Effect Size *d*)
Motivating Factors	*Save* †	Protect, help, benefit, save lives/people/the world (through medical science)	"Through the pandemic, I felt that the medical science I was studying could save lives".	8 (32)	3 (25)	11 (29.7)	0.487 (0.409)
	Truth †	Importance of having/collecting/ disseminating correct information/knowledge	"We are in the midst of a pandemic in the Internet age, a situation of unprecedented information overload, and it is important to be able to discern what is correct and what is fake".	6 (24)	3 (25)	9 (24.3)	0.624 (0.346)
	Research †	Became interested in medical science/virology/ infection biology/new research fields	"I started to take a new interest in research fields related to COVID-19. Until now, I was not very interested in the fields of virology and drug discovery, but I became interested in this situation".	5 (20)	4 (33.3)	9 (24.3)	0.311 (0.486)
	Value of Studies †	Saw the value/meaning/importance/ duty of medical science studies	"Through the pandemic, I felt that the medical science I was studying could save lives. As a result, I realized that the medical science was useful, and motivated me to study".	6 (24)	3 (25)	9 (24.3)	0.624 (0.346)
Demotivating Factors	*Online Bad*	Online Classes/lectures are boring/bad/ have more disadvantages than advantages	"I feel that the prevalence of COVID-19 has discouraged me from learning. This is because I have not been able to take advantage of the various opportunities to gain knowledge in the medical field and because the format of online lessons does not suit me".	6 (24)	4 (33.3)	10 (27)	0.412 (0.442)
	Robbed	Covid robbed me of my college life/events/experiences	"COVID-19 has robbed our precious college life".	7 (28)	2 (16.6)	9 (24.3)	0.376 (0.457)

† Indicates medical science-specific coding labels.

Of the 38 distinct coding labels identified from both groups (both motivating and demotivating factors), 23 were specific to the medical science/medical/healthcare profession. The vast majority (n = 21) of the medical science-specific codes were representative of motivating factors. Of the 15 coding labels that were not specific to medical science, 10 were demotivating factors that were largely related to the various stresses of the lockdown situation, such as *Online Bad* and *Lonely*. In Tables 1 and 2 (and Supplementary Tables S1–S4), these medical science-specific codes are indicated with a cross (†). Figure 3A,B shows the proportions of the medical science-specific to the non-specific coded statements (Groups 2020 and 2021 combined) for motivational factors (Figure 3A) and demotivational factors (Figure 3B), respectively.
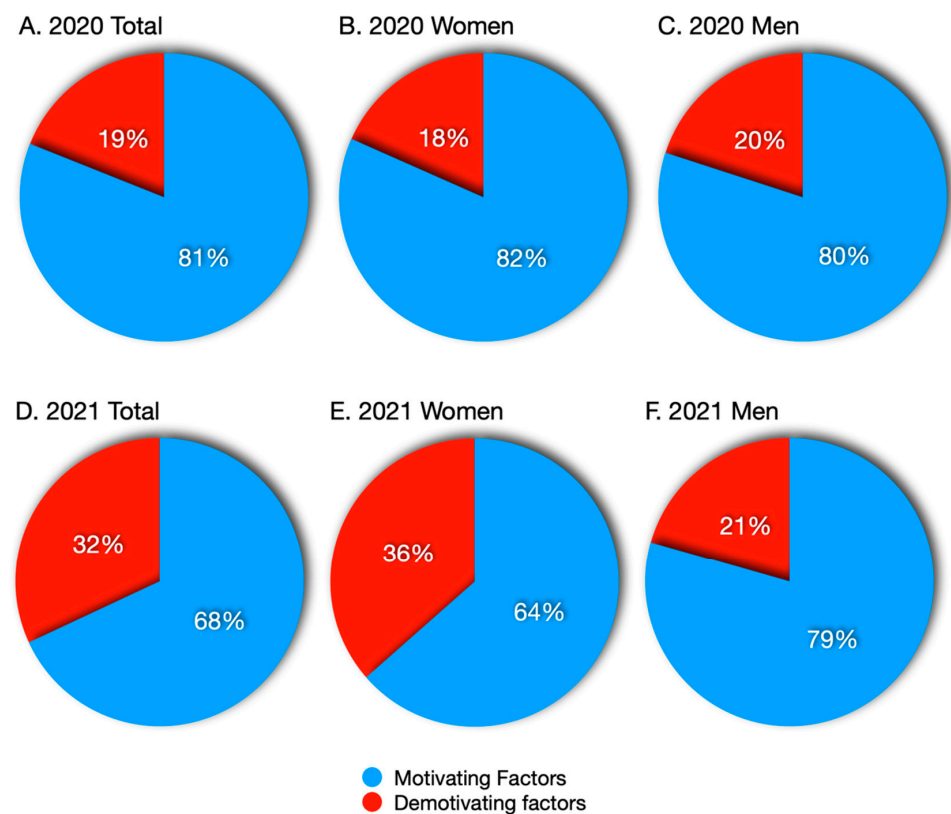
Figure 2. Proportion of coded statements expressing motivating factors to those expressing demotivating factors.
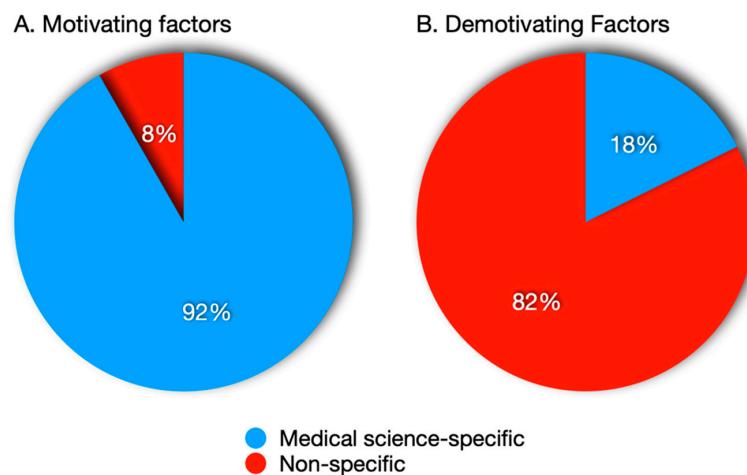

Figure 3. Proportions of medical science-specific to non-specific coded statements (Groups 2020 and 2021 combined) for motivational factors (**A**) and demotivational factors (**B**).

The proportion of medical science-specific factors was much greater among the motivational factors (92%; Figure 3A), while the non-specific factors dominated the proportion of demotivating factors (82%; Figure 3B). Figure 4 shows the proportions of coded statements from the students who were counted as stating decreased motivation.
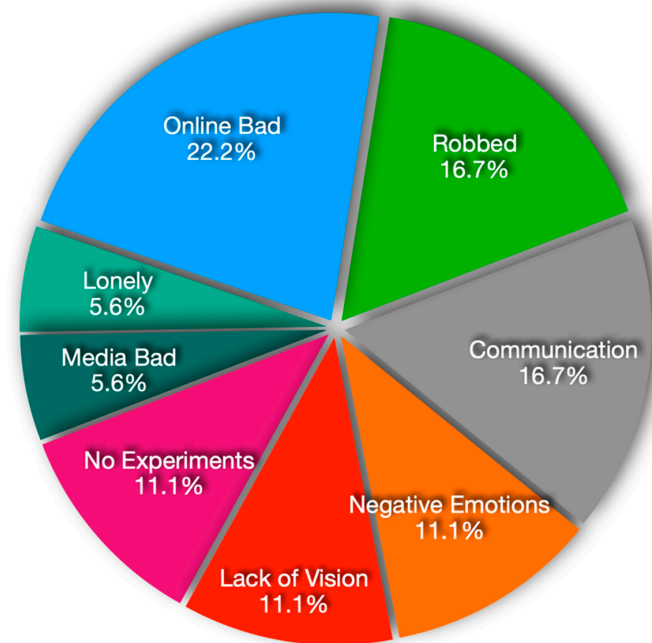
Figure 4. Proportions of coded statements from the students who reported decreased motivation. All students were women from Group 2021.

There were 16 overlapping (common) codes that were derived independently from both groups. Table 3 shows a statistical comparison (p values and effect size) of these common codes between the two groups and separately by sex. Comparing the two groups, the codes of significance were found for the motivating factors of Save (p = 0.026; d = 0.507), Heroes ($p \leq 0.001$; d = 0.632), and Research (p = 0.028; d = 0.479) and the demotivating factors of Negative Emotions (p = 0.035; d = 0.493), Online Bad (p = 0.037; d = 0.490), and Robbed (p = 0.046; d = 0.479). Among women, significance was found for the factors Heroes (p = 0.004) and Robbed (p = 0.028), while for men, significance was found for Save (p = 0.041) and Heroes (p = 0.019).

Table 3. Statistical comparison of common codes between Group 2020 and 2021.

Coding Label	Women p	Men p	Total p	Effect Size d
Save	0.242	0.041 *	0.026 *	0.507
Heroes	0.004 **	0.019 *	<0.001 **	0.632
Truth	0.305	0.5	0.315	0.345
Contribute	0.967	0.097	0.249	0.367
Link	0.187	0.109	0.967	0.001
Research	0.104	0.322	0.046*	0.479
Online Good	0.967	0.5	0.615	0.249
Vision	0.5	0.5	0.984	0.001
Developing Countries	0.967	0.5	0.588	0.259
Negative Emotions	0.073	0.239	0.035 *	0.493

Table 3. *Cont.*

Coding Label	Women p	Men p	Total p	Effect Size d
Lonely	0.65	0.109	0.43	0.309
Discrimination	0.32	0.5	0.719	0.208
No Experiments	0.967	0.5	0.674	0.227
Online Bad	0.055	0.32	0.037 *	0.490
Robbed	0.028*	0.65	0.046 *	0.479
Being Home	0.65	0.5	0.615	0.249

* Indicates statistically significant *p*-values, ** Indicates strongly statistically significant *p*-values.

4. Discussion

Overall, the findings of this study point to relatively high proportions of increased motivation to study among our medical science students. In Group 2020 (those who had experienced 4 months of online study), while 4% of the students said they had experienced decreased then increased motivation and 7% had no change, no students reported purely decreased motivation. In Group 2021, however, the proportion of students reporting decreased then increased motivation rose to 19% overall, and 19% of the students (all women) reported decreased motivation. As seen in some European studies of school students and undergraduates experiencing a similar lockdown period, motivation seems to have decreased due to many factors, including poor internet access, socioeconomic factors (loss of part-time work), perception of online studies as being less useful, and so on [2,17]. In contrast, as the greater proportion of students reported increased motivation in both groups (2020 and 2021), our results indicate that, overall, the pandemic has had a positive impact on the Japanese medical science students' motivation to study. This finding seemingly runs contrary to other studies on this topic, which largely deal with the overwhelmingly and unfathomably profound negative impact that the pandemic has had on student education; however, the results of our coding analysis perhaps give some insight into some of the reasons behind this anomaly.

Our coding analysis revealed that the underlying factors behind this increased motivation were largely connected to how the COVID-19 pandemic had brought to light the importance of their chosen profession as clinical laboratory technicians or medical science researchers. In their essays, the students expressed a desire to save, help, and protect people through medical science and to contribute to the innovation of new testing methods, vaccines, and drug development. The pandemic had suddenly thrown a spotlight on medical researchers, technologists, and front-line health care workers heroically working selflessly for others, which allowed the students to gain new respect for, and take pride in, their chosen profession and gave some of them a clear vision of their future. This psychological boost to perceived professional self-esteem has been shown to increase individual empowerment as well as satisfaction in occupational choices [18]. The increased media attention and, more importantly, social media attention raised a strong awareness of the importance of having, collecting, and disseminating correct and accurate information, especially with the threat of misinformation, as detailed in an increasing number of studies [19–21]. Some students even expressed feeling frustration at their own lack of knowledge when friends and family asked them medical science-related questions that they could not answer, which motivated them to study. Turana et al. touch upon this in their study, suggesting that medical students played a critical role during the pandemic by disseminating COVID-19-related information, especially to friends and family [6].

The most frequent code was that of *Save*, which was used to categorize the statements that described the desire to protect, help, and save lives through medical science (Group 2020 = 55%; Group 2021 = 29.7%) and was also frequent among both the men and the women. One student wrote about the desire to save others as follows: "If medical science

students study medical science hard and play an active role in the medical field, as a result, we can help save people from pandemics". This desire to help/save others is a common phenomenon, particularly among women, and Miller and colleagues (in their study of the goals of female science undergraduates) state that "when women plan a career that includes research, they tend to embed it within a helping profession and/or a desire to help others" [22]. Miller and colleagues describe this desire to help others as a "prosocial" attitude, and when categorizing the coding labels in our study from this perspective, it could be said that alongside *Save* the codes of *Contribute*, *Developing Countries*, *Mission*, *Vaccine*, and *Solution* could all be considered as prosocially leaning as they all touch upon a desire to help others. However, when segregated by sex, both the women and the men in our cohort of medical science students wrote statements affirming these motivational codes at an equal ratio. Indeed, the statistical analysis of the differences in the coding statements by sex found some statistical significance in only two codes: *Contribute* ($p = 0.073$; Table 1) and *Innovation* ($p = 0.046$; Table 2), both of which were more frequent among the men than the women.

As mentioned in the results, most (21 out of 26) of the coding labels that represented motivating factors were specific to the medical science profession, and these codes account for the majority (92%) of the coded motivational statements (Figure 3A). On the other hand, most of the coding labels that represented demotivating factors (10 out of 12) were not specific to medical science and were related to the pandemic-induced lockdown and studying online alone at home; these accounted for the majority (82%) of the coded de-motivational statements (Figure 3A). Our findings demonstrate how far the COVID-19 pandemic has positively influenced our students' motivation to study medical science, while the experience of studying from home has been, overall, a demotivating experience.

Our findings of overall increased motivation among our cohort are in contrast with those of most other studies. For example, Meeter and colleagues' study of undergraduates at a Dutch research university found that student motivation decreased after the COVID-19 pandemic and that the decrease was mainly due to the limitations of online learning [23]. Their study revealed that decreased motivation was linked to the facilities for online education, i.e., not having a quiet place to study and bad internet connection, plus a lack of social interactions [23]. In this respect, however, our findings were similar; with many of the demotivating factors being connected to the limitations of online study, the lack of laboratory experiments, and the lack of social interactions. Importantly, the proportion of students who were coded for *Online Bad*, grew from 8.3% in Group 2020 to 27.7%, suggesting that, for this second cohort of students whose entire university experience has been disrupted by the pandemic, online learning has been particularly difficult. A number of recent studies have discussed in detail the application, advantages, and disadvantages of online modes of learning in relation to the COVID-19 pandemic [2,3,17,24–31], and while this is not the focus of the current study, it is an important observation that the demotivating factors we observed were largely attributable to online learning and, moreover, the broader picture of student life in lockdown. This finding is also observed in the statistical analysis presented in Table 3, where Group 2021 had a significant increase in the frequency of the codes *Online Bad* ($p = 0.037$) and *Robbed* ($p = 0.046$).

With regard to the motivation of students in a digital/online curriculum, Tan (2021) reported that a cohort of 282 Malaysian university students had an initially high motivation but a high dependence on social presence was closely tied to learning motivation, which dropped over time as a result of decreased social interaction due to online learning [32]. This would correlate well with our results, which indicate that *Online Bad*, *Lonely*, *Communication*, and *Robbed* (cumulatively, 62% of the total responses for those students who reported decreased motivation) were demotivating factors closely tied to lack of social contact, group experience dynamics, and missed opportunities to bond with peers. It is also important to note that these factors are not associated with medical science in particular. However, a study in a European medical school found that 198 students found that online methods which emphasized a game-centric interface and embedded learning through cases kept

motivation high even under pressure from asynchronous assignments [33]. In contrast, the online structure of content delivery in our system was perhaps insufficient for our students who experienced demotivation; it could be possible that the content delivery system itself is a key factor in preventing demotivation and Japan, which was well behind the West in leveraging online modes of learning before the pandemic [34]. Universities in Japan were, arguably, not fully equipped or prepared to provide the online content management and planning that fits well with a professional-license educational model. Indeed, some studies among Japanese medical students have pointed to the difficulties, drawbacks, and even mental distress caused by the shift to online leaning [34,35].

Our results trending towards increased motivation were similar to those of Armstrong-Mensah and colleagues, who, in their survey of graduate and undergraduate students of public health in the United States, found that 53.6% of the students reported being able to stay motivated while only 3.4% of the students reported difficulty in staying motivated to learn [31]. This similarity may be attributable to the fact that the participants of this study were from the field of public health, who, like our students, would have seen a clear link between their chosen profession and the pandemic situation. However, a study by Rahiem, involving social science education majors in Indonesia, also revealed that students were able to maintain positive attitudes towards learning despite being forced to study at home because of the pandemic [36]. Importantly, the data for these two studies were collected in 2020 when, perhaps, the novelty of studying online from home had not yet worn off. The findings of our analysis of the essays from Group 2021, in contrast, show a marked rise in the number of students who reported decreased motivation and a greater proportion of demotivating factors to motivating factors in their essays. This could indicate that the prolonging of COVID-19 countermeasures, online learning, and reduced social activities may have had a negative effect on the students' motivation to study.

The number of responses that were coded as demotivating factors, while not as numerous as the motivating factors, should not be ignored, especially considering that the proportion of demotivating factors grew from 19% in Group 2020 to 32% in Group 2021. Many students wrote about feeling negative emotions such as fear, stress, and anxiousness, some felt lonely, and many felt robbed of their college life. In a recent study involving undergraduate psychology students from Brazil, Godoy and colleagues found that most students spent 1 to 3 h (range 1 to >7) a day watching media or thinking about the coronavirus, and they observed strong correlations between a preoccupation with the coronavirus and fear [37]. Like our study, most of the students in this sample were women (20 women to 8 men). Godoy and colleagues point out that, among the Brazilian population, the COVID-19 pandemic aggravated anxiety and distress, particularly among women and young adults [37]. This is borne out in our study, too, with all the students professing decreased motivation being women.

As seen in Figure 4, the reasons behind the decreased motivation observed in our study appear to be due to the restrictions of a life in lockdown: online learning, lack of social interactions, missing communication with friends, being robbed of a range of experiences associated with college life, feelings of fear, anxiety, and loneliness, and losing sight of their future. Son and colleagues, in their study of the effects of COVID-19 on university student mental health in the United States, found that 71% of the students in their sample showed increased stress, anxiety, and depressive thoughts [34]. Among the primary stressors that they identified, decreased social interactions due to physical distancing was reported by 86% of the sample [34]. Walters et al. similarly point out that pre-clinical medical students were more likely to have burnout and stress related to social isolation and to have the need for mental health and support services [35].

As seen in Table 3, which details the statistical analysis of the overlapping codes comparing Groups 2020 and Group 2021, some codes were significantly different between the two groups, suggesting that some factors had shifted as the pandemic restrictions were drawn out month after month. While *Save* was the most frequent code in both groups, there was a significant decrease in its frequency among men in Group 2021 ($p = 0.041$),

implying that this strong desire to help people had dwindled somewhat, especially among men. The most striking difference, however, was observed in the code *Heroes* ($p \leq 0.001$), which showed a dramatic reduction in frequency among both men and women. There are some possible explanations for this; the initial media focus on medical scientists may have either lessened (perhaps following the creation of the vaccine) or become diluted over time. Furthermore, the media reports, especially those frequently shared on social media, have tended to be unrealistic, and polarization over hot-button issues (such as vaccination) may have had a counteracting effect on the self-image of medical professionals [36].

4.1. Implications

The COVID-19 pandemic has brought unique exposure to the field of medical science and the work of clinical laboratory technicians and medical science researchers. Suddenly, technical terms such as "PCR", "antibody", and "antigen" have become part of the common parlance. This spotlight on medical science has given our students a clear vision of their future selves; it has shown them the importance of their studies and their chosen profession and how they can contribute to society by helping others, even saving lives, through their work. Indeed, picking up on this motivation, a number of universities have used the pandemic as a way to promote educational programs for medical laboratory technicians [38,39]. We found that our students were able to take pride in and gain new respect for their profession and for themselves, as illustrated by this student's statement that:

> "Being a clinical laboratory technician is a job to be proud of. The COVID-19 pandemic has caused a lot of talk about health care workers putting their lives on the line for their work. Clinical laboratory technicians are also part of the medical profession. The clinical laboratory technician has been an inconspicuous occupation, but this time, it has attracted a lot of attention. But clinical laboratory technicians are responsible for intervening in the field of medicine, and I thought it was a job I could be proud of".

This increased future awareness in students pursuing a certification has, for the most part, overridden the disadvantages and difficulties of studying online and the restrictions imposed on them by the pandemic response. From the students' reports, it appears that overcoming the limitations of online learning may rely on developing a sense of professionalism, which the professors could encourage. Educators could leverage the pandemic as a teaching tool to motivate professional degree students even in classes limited by online interactions. Accepting that online learning will play a significant part in education going forward, hybrid classes, where in-person instruction can occur, may be therefore best utilized for intense practical/technical instruction, while the motivational and didactic education is delivered online to maintain the students' sense of their future utility in the workforce.

The findings of the current study and others [37] suggest that the pandemic has had a particularly negative effect on women. In light of the findings that indicate the negative impact of the pandemic on mental health [5,37,40–43], universities need to seek interventions to help their students through these times. Finding ways to build a sense of community, forge friendships, conduct group work assignments, and network would be helpful in alleviating this problem, particularly if the current situation is extended because of waves of new variants.

4.2. Limitations

There are limitations to the current study. First, the number of participants is small and from a single institution in Japan. A larger-scale study involving multiple institutions, whether international or domestic, would be useful to verify the generalizability of the findings. The finding of a trend towards decreased motivation is based only upon the data collected at two time points; future studies to investigate the same cohort multiple times across their undergraduate years could verify this trend. Furthermore, the data were

collected only from second-year undergraduate students; thus, it would be interesting to see how the COVID-19 pandemic impacted students across all four years of undergraduate study. Finally, other more objective data points, such as test scores or questionnaire surveys with established instruments, would be helpful in the triangulation of our data, which are based on subjective, self-reported essays. A limitation with our data collection method is that we cannot rule out the possibility of social desirability bias; i.e., there is a chance that the students did not want to appear too negative in their essays, especially to authority figures, and the students were aware that the essays would form a small part of the students' coursework evaluation. Furthermore, the students were writing the essays in a foreign language (English), which may have also had some biasing effect. However, the overall consistency of the responses, namely the patterns in motivation status and the underlying factors throughout both groups, strongly suggests that any bias may have had minimal implications for the legitimacy of the essays as valuable sources of data.

Another important point is that these results may not be applicable to the general student population as medical science students are pursuing a professional degree that requires a consistently high level of motivation to complete all the licensing requirements. Thus, our results may only be useful for comparison to other licensure-focused programs (e.g., medical, engineering, or technical) with regard to occupationally specific motivation factors. In light of this, the studies conducted in non-pandemic years may be divergent from the conclusions reached in this study as the visualization of a student's professional future may be different due to the public exposure of jobs that are important during such times.

5. Conclusions

In conclusion, through our analysis of the data gathered from two groups of undergraduate medical science students, we have been able to find that the COVID-19 pandemic has increased their motivation to study. This was particularly marked in the students who wrote their essays in 2020, just four months into the lockdown measures. Medical science students being able to see a vision of their future selves as important parts of the healthcare system seems to reaffirm a desire to save/help others and contribute to the well-being of society. However, in the students' essays from 2021, while we still saw most of the students reporting increased motivation, there was a greater proportion who reported decreased then increased motivation and some—all women—who reported purely decreased motivation. This decreased motivation stemmed from the stresses of online education and life in lockdown, which indicates that the pandemic and the measures could be having a negative effect in the long term.

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