Academia During the COVID-19 Pandemic: A Study within the Geo-Science and Engineering Field

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Abstract

The COVID-19 pandemic has had a profound effect on both education and research activities. A survey conducted within the geotechnical engineering and earth science academic communities between April 22 and 24 explored the variables that affect working efficiency and intellectual development during the pandemic period. We received 274 complete responses from faculty and graduate students in North America, Europe, South Korea, and Saudi Arabia. The four variables that correlate best with individuals' perceived consequences of the pandemic are:
setting daily goals, focus on academic tasks, time spent reading literature outside core research or on professional development, and commitment to exploring deeper scientific concepts. Overall, 28% of the respondents exhibit a positive outlook. For the other 72%, living with nonfamily members or with children, hindered access to needed materials, and excessive time spent with video entertainment exacerbated the perception of potential negative consequences of the pandemic. Observed percentages and trends are very similar across age, gender, living conditions and regardless of regional/national restrictions. Two complementary surveys addressed faculty choices for online education and student preferences. These results document the effective transition from in-person to online education using readily available technology, and highlight students' preferences for in-person education followed by live online platforms; pre-recorded lectures emerge as the least preferable choice.

Keywords: COVID-19, working efficiency, intellectual development, academia, online learning, survey

Pandemics have affected and shaped societies for millennia, including the Antonine plague (between 160 and 189 AD; Sabbatani & Fiorino, 2009), the bubonic plague (14th century;
Stenseth et al., 2008), Spanish flu (1918 – 1919), and more recently HIV aids, the ebolavirus, SARS and swine flu (LePan, 2020). Typically attributed to urbanization, transportation and migration patterns, geopolitical and demographic changes, and the adaptability of microorganisms, pandemics appear to be increasing in frequency (McMichael, 2004;
Destoumieux-Garzón et al., 2018).

The current global COVID-19 pandemic has forced the international academic community to reconsider educational delivery and assessment methods, advance research without laboratory access, and to maintain academic interactions online with both students and colleagues. Recent large-scale surveys of university students during the COVID-19 period have examined the impact of the coronavirus on student

study plans, university responses to the crisis, attitudes and experiences of online learning and student mental health. In Europe, 66% of students report difficulties in maintaining their concentration during online learning, over half perceive that they are not progressing as effectively as they would on campus and indicate that isolation negatively impacts their motivation (Tormey et al., 2020). Results from China suggest that economic uncertainty, academic changes and social distancing measures have caused increased student anxiety (Cao et al., 2020). As the duration of the pandemic extends, its effects become deeper and more apparent throughout the scientific literature. For example, comments and opinions in the journal *Nature* during April capture the impact of this period on academic productivity (Minello, 2020), logistical challenges (Paterlini, 2020) and the importance of maintaining connections and advancing research despite physical distance (Bardelli, 2020). This paper explores the impact of the COVID-19 pandemic on academic and daily activities in four distinct geographical areas. In particular, we seek to identify the variables that affect working efficiency and intellectual development during the pandemic.

Methods

The Survey

The main survey consists of 20 multiple choice questions and two open-ended questions hosted on Survey Monkey, ("SurveyMonkey", 2020 - The survey appears in Appendix 1). The first four questions span basic demographic information, followed by ten questions that aim to provide a snapshot of respondents' lives during the survey period. The subsequent four questions require respondents to compare some elements of their situation during the pandemic and before restrictions started. The last two questions ask for estimates of the impact of the pandemic on their research and intellectual development and on their careers. The survey concludes by inviting respondents to share any insights regarding the impact of the coronavirus pandemic on their lives.

Respondents

Survey links were emailed to faculty and graduate students in the geotechnical engineering and earth science academic communities in North America (Canada and the USA), Europe
(primarily Belgium, Italy, Spain, France, the UK, Germany and Switzerland), South Korea, and King Abdullah University of Science and Technology KAUST in Saudi Arabia. Distribution benefitted from research networks, thus the number of people who received the survey links is unknown. We used the same survey but with four different links to discriminate answers according to geographic zone. All responses remained anonymous and there was no incentive provided for participation. The survey remained open for 48 hours.

Time and Context

The survey took place during April 22 to 24. Local restrictions at the different locations during the survey period ranged from "minimal changes to daily life" (South Korea), "some changes to daily life" (Switzerland, Germany), "partial lockdown" where employees are required to work from home, with travel

limited to essential grocery shopping and medical appointments, and where outdoor exercise may be permitted but with some restrictions (Canada, France,
Belgium, England, KAUST in Saudi Arabia, and in some parts of the USA), and "total lockdown" restrictions on all but essential movement, including outdoor exercise (Italy and Spain).

The number of coronavirus cases and deaths varied throughout the four areas, as shown in Figures 1a&b. Contrary to reports in the media that tend to highlight the total counts in a given country, data in these figures are normalized by the corresponding country's population to reflect the probability of individuals being directly affected by a case within their immediate circles.

The pandemic and ensuing restrictions had a rapid and pronounced effect on the economic system. For reference, Figure 1c shows the drop in the stock market, represented here by the Dow Jones Industrial Average DJIA, and the fast rise in unemployment claims. The survey took place during the fifth week after the lowest point in the DJIA, while the high continued unemployment claims made daily news.

Results and Analyses

We received a total of 274 complete responses out of 304 respondents from Europe (153), North America (55), South Korea (21) and KAUST (75). Figure 2 presents the age break-down of all respondents. They are predominantly male (with the smallest proportion of female respondents from South Korea 4%), and only 30% live with children. Most respondents are between 26 and 40 years old (67%). Given the age distribution, we anticipate about half are graduate students and the remainder postdoctoral fellows, research scientists and faculty members.

Main Variables, Predictive Model

Answers to the last three multiple choice questions provide a direct self-assessment of individuals' perceived consequences of the pandemic: (Q18) compares the effectiveness in research or study tasks during and before the pandemic, (Q19) the perceived effect of the pandemic on research and intellectual development, and (Q20) the anticipated effect on career path and timing. Histograms in the first row of Figure 3 summarize the responses to these 3 questions according to geographic origin. There is an overall negative balance, and respondents are 2.5 times more likely to report a decrease rather than an increase in efficiency and a negative impact on intellectual development as a result of the pandemic.

On the other hand, a comprehensive correlation analysis helps us to identify potential causal links. The four variables that emerge as the strongest predictors of individuals' perceived consequences of the pandemic are: (Q6) setting daily goals, (Q7) ability to focus on academic tasks, (Q13) time spent reading literature outside core research or on professional development, and (Q17) commitment to exploring deeper scientific concepts. Histograms in the second row of Figure 3 summarize the responses to these four questions colored by geographic origin. The most negative causal variable is diminished ability to focus. Once again, overall trends show significant parallelisms among responses from different countries.

We use a multivariate analysis to develop a predictive model that relates the effects of both personal and professional factors on the perceived impact of the coronavirus period. The model combines the main variables identified above into "**causal**" variables and their "**effect**" on individuals' perception as follows

(Note: this analysis requires converting verbal responses and ratings to a numerical scale; adopted values are shown in Figure 3 but were not visible to respondents):

cause= [1 (daily goal)
+ 5 (ability to focus)
+ 2.5 (emphasis on personal development)
+ 1 (commitment to exploring deeper concepts)] / 12.5

effect= [2.6 (change in research effectiveness)
+ 1.3 (perceived effect on research and intellectual development)
+ 0.8 (perceived effect on career path and timing)] / 9.4

The plot in Figure 4 shows the **cause** and **effect** data point for each respondent. Note that 72% of all respondents have a negative perception about the potential consequences of the pandemic (effect □ 0). The trend between **cause** and **effect** has a high coefficient of determination $R^2 = 0.59$. The 'ability to focus' (Q7) may be considered a consequence rather than a cause; if this variable is removed from **cause**, there is still a marked correlation, but the coefficient of determination falls to $R^2=0.38$. Overall, trends are statistically similar for the different geographic regions.

Other Variables

Weak predictors of a positive outlook during this period include male gender (a slightly more positive outlook than women), planning weekends differently to weekdays, significant time spent writing technical documents, and age between 31 and 40 years. Variables associated with a more negative perception are (albeit weakly): living with others (not family), living with children, hindered access to materials needed to work from home, and limited time devoted to reading literature outside the core research area (less than 30 minutes per day). While some variables have a low correlation with perceived consequences, they still provide valuable information. For example, those who live with family members are 1.4 times more likely to feel less effective in research or study tasks than those who live alone. In particular 63% of women and 54% of men report a decreased focus on academic tasks (Note: more men report living with children than women in this group). Respondents who exercise less than 30 minutes per day are 2.5 times more likely to report being less efficient than those who exercise for at least 30 minutes each day. In addition, those that watch more than one hour of TV/movies/videogames per day have a 2.5 chance of reporting being less effective at the time of the survey than before the pandemic.

Responses to Open-ended Questions

We received a high level of responses to the two open-ended questions, identifying both negative and potentially positive consequences of this period. Common negative affects relate to diminished job and career prospects, the associated financial concerns and overall uncertainty about the future; these responses are consistent with economic indicators during the survey window (Refer to Figure 1-c). Other concerns address the decrease in ability to maintain focus, setback in experimental work, the impact on mental health (including exacerbation of preexisting mental illness), and loneliness. On the other hand, a frequent positive

comment, common to all geographic and age groups, was that the pandemic period has given individuals the time to think and reflect on what is important – both personally and professionally.

Complementary Surveys

Two additional short surveys compliment the main survey summarized above and address institutional and faculty choices for online delivery, and students' preferences.

Faculty: Technology

The first dataset identifies both the online platforms used for distance learning and the preferred technologies selected by faculty during the rapid transition from in-class to online teaching during the early stages of the lockdown. This survey was conducted during the first week of April 2020 and explored online delivery methods, technology, exams and grading systems. The 16 geotechnical professors represent universities in Argentina, KSA/KAUST, South Korea, France, Switzerland, UK and the USA. Faculty deliver live online content, prerecorded lectures and tutorials using various online platforms including Google Meet, Moodle, Weblearn, Microsoft Teams and Canvas, Discord, YouTube, Zoom, BlueJeans, Kaltura and Canvas, and Zoom. A common strategy involves sharing files with students. In general, faculty report high student satisfaction with online content that focuses on case studies, however they note students fatigue after about four hours of remote learning per day.

Students: Lecture Style Preferences

The second complementary survey examined the preferences of KAUST graduate students in geoscience for lecture delivery styles and took place at the end of the semester, between May 20 and May 23. The majority of the 34 anonymous respondents had transitioned from inclass to online education during the past semester. The survey asked respondents to rate the various lecture delivery styles: (1) in person, (2) live online (e.g., via Zoom), and (3) through prerecorded online videos (e.g., Youtube). Finally, it encouraged respondents to share underlying reasons for their preferences and recommendations to improve the overall experience.

Figure 5 shows histograms for the three set of responses. "Good" and "Very Good" account for 85% of the responses for in-person delivery, 58% for live online, and 39% for online prerecorded. Respondents who prefer in person lectures frequently note the benefits of personal and direct interaction with the faculty and other students; enhanced concentration, engagement and motivation in a classroom setting; and classes better tailored to the students' needs. In the case of live online classes, respondents advised faculty to focus on interactions with students and suggested using quizzes as a strategy to increase engagement. On the other hand, they recognized potential benefits in pre-recorded lectures. Besides time flexibility and the ability of students to repeat sections for clarification, prerecorded lectures that occur at a scheduled time with the faculty member available during the class period to answer questions combine positive features of each style.

Overall, these results suggest that there is a clear opportunity for online lectures (either live or pre-recorded). Further developments require technological developments, increased technological proficiency

(both faculty and students), and improved delivery styles to interact and engage students to enhance their educational experience.

Conclusions

The COVID-19 pandemic has tested the academic system worldwide. We have to rapidly transition to new forms of distant communication and online delivery of education, and have to focus on research tasks that allow for remote operation in lieu of laboratory tasks.

This study shows that 28% of respondents managed to find an overall positive outcome to the pandemic. However, the majority anticipate negative consequences on intellectual development and career path. Notably, these percentages are very similar across age, gender, living conditions and regardless of regional/national restrictions.

Variables associated with a more negative perception are: living with others (not family), living with children, hindered access to materials needed to work from home, limited time devoted to reading literature outside the core research area, and excessive time watching TV/movies/videogames. While active physical activity is often recommended to overcome the negative impact of restrictive environments, exercise showed only a minor correlation with efficiency and almost no correlation with individuals' long-term outlooks.

Those who have reacted most positively to the pandemic tend to set daily goals, remain focused on intellectual tasks and on personal development, and spend more time exploring deeper concepts. In fact, several in this group consider this period as a unique time to reflect, identify priorities, explore new concepts and advance great research.

The pandemic prompted the largest experiment on distance learning across the international community. Limited results show a lagging preference for in-person education. However, online education has done well, particularly for live delivery rather than pre-recorded lectures.

References

Bardelli, A. (2020). Coronavirus lockdown: what I learnt when I shut my cancer lab in 48 hours. https://www.nature.com/articles/d41586-020-00826-7

Cao, W., Fang, Z., Hou, G., Han, M., Xu, X., Dong, J., & Zheng, J. (2020). The psychological impact of the COVID-19 epidemic on college students in China. *Psychiatry research, 287*, 112934-112934. doi:10.1016/j.psychres.2020.112934

Destoumieux-Garzón, D., Mavingui, P., Boetsch, G., Boissier, J., Darriet, F., Duboz, P., Fritsch, C., Giraudoux, P., Le Roux, F., Morand, S., Paillard, C., Pontier, D., Sueur, C & Voituron, Y. (2018). The one health concept: 10 Years old and a long road ahead. *Frontiers in Veterinary Science, 5*(14), pp.1-13, doi:10.3389/fvets.2018.00014

LePan, N. (2020). Visualizing the history of pandemics, https://www.visualcapitalist.com

McMichael, A.J. (2004). Environmental and social influences on emerging infectious diseases: past, present and future. *Philos Trans R Soc Lond B Biol Sci, 359*(1447), 1049-1058. doi:10.1098/rstb.2004.1480

Minello, A. (2020). The pandemic and the female academic. https://www.nature.com/articles/d41586-020-01135-9

Paterlini, M. (2020). Lockdown in Italy: personal stories of doing science during the COVID-19 lockdown. https://www.nature.com/articles/d41586-020-01001-8

Roser, M., Ritchie, H., Ortiz-Ospina, E., & Hasell, J. (2020). Coronavirus Pandemic (COVID-19). *OurWorldinData*, https://ourworldindata.org

Sabbatani, S., & Fiorino, S. (2009). The Antonine Plague and the decline of the Roman Empire. *Infez Med*, *17*(4), 261-275

S&P Dow Jones Indices (2020). Dow Jones Industrial Average, https://us.spindices.com Stenseth, N.C., Atshabar, B.B., Begon, M., Belmain, S.R., Bertherat, E., Carniel, E., Gage, K.L., Leirs, H., & Rahalison, L. (2008). Plague: past, present, and future. *PLoS Med*, *5*(1), pp. 9-13, doi:10.1371/journal.pmed.0050003

SurveyMonkey Inc (2020). https://www.surveymonkey.com

Tormey, R., Sarrade I., & Jermann, P. (2020). *Online learning experience questionnaire.* Teaching Support and Center for Digital Education, EPFL, https://www.epfl.ch

US Department of Labor (2020). *Unemployment insurance weekly claims data*, https://oui.doleta.gov

Appendix 1: CORONAVIRUS 2020

The main survey is reproduced here in its entirety

General

1. Do you live alone, with family or with others?
   - Alone
   - With family
   - With others

2. Do you have children living with you?
   - Yes
   - No

3. Select your age group
   - 18 – 25
   - 26 – 30
   - 31 – 40
   - 41 – 50
   - 51 +

4. Select your gender Male
   - Female

A snapshot of your life today during the coronavirus pandemic

5. Do you plan your weekends differently than weekdays?
   - Yes
   - Sometimes but not always
   - No

6. Do you set yourself a daily goal?
   - Always
   - Often (4 or 5 times per week)

   Sometimes (2 or 3 times per week)

   Never

7. Has your ability to focus on your study/research changed since the beginning of the pandemic?
   - My ability to focus on my work has increased
   - No change

- My ability to focus on my work has decreased

8. Has your number of work/study related meetings changed since isolation?
   - Increased
   - Remained the same
   - Decreased

9. Do you have access to all the materials that you need to work/study from home?
   - Yes
   - No. Please comment.

How much time do you currently spend every day (think in terms of a weekly average) on:

10. Physical exercise
    - Less than 30 minutes
    - 30 minutes – 1 hour
    - 2 hours
    - More than 2 hours per day

11. Interacting with friends and family (online and in person):
    - Less than 30 minutes
    - 30 minutes – 1 hour
    - 2 hours
    - More than 2 hours per day

12. Watching TV, movies and video games:
    - Less than 30 minutes
      30 minutes – 1 hour
      2 hours
    - More than 2 hours per day

13. Reading literature outside your core research or on professional development:
    - Less than 30 minutes
    - 30 minutes – 1 hour
    - 2 hours
    - More than 2 hours per day

14. Writing technical documents (theses, papers and reports):
    - Less than 30 minutes
    - 30 minutes – 1 hour

- 2 hours
- More than 2 hours per day

Comparing your current situation and your activities before the beginning of the pandemic, are you…

15. Exercising
    - Much less
    - Less
    - About the same
    - More
    - Much more

16. Focused on your personal and professional development
    - Much less
    - Less
    - About the same
    - More
    - Much more

17. Exploring deeper/alternative concepts or theories
    - Not really
      About the same
      Much more, decisively

18. Effective in research or study tasks
    - Much less
    - Less
    - About the same
    - More
    - Much more

Overall, please assess the effect that the coronavirus pandemic will have…

19. On your research and intellectual development
    - Major negative effect
    - Some fall back
    - No effect
    - Some benefit
    - Great benefit

20. On your career path and timing
    - Major negative effect
    - Some fall back
    - No effect
    - Some benefit
    - Great benefit

21. Please feel free to share any insights that you may have regarding the impact of the coronavirus pandemic on your life. Responses will remain anonymous.

Figure 1:

Timeline from January 1 to May 9, 2020 and the surveys' timing. (a & b) Confirmed number of cases and deaths normalized by national populations in the surveyed countries. (c) Dow Jones Industrial Average and US unemployment claims (seasonally adjusted, continued unemployment claims). Data sources: Roser et al., (2020), S&P Dow Jones Indices, 2020, US Department of Labor (https://oui.doleta.gov)

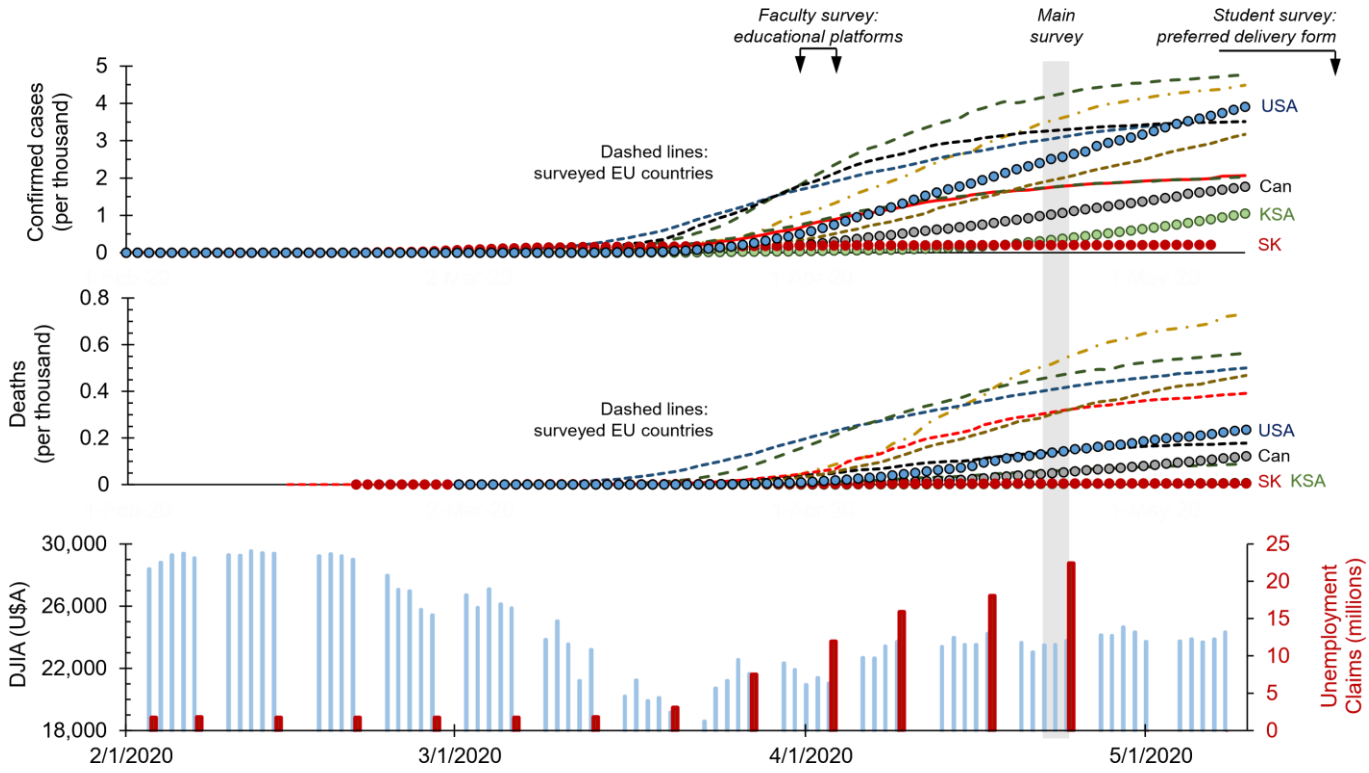


Figure 2:

Age of survey respondents. The interpretation of the different age groups reflects common trends in the geo-science and engineering field. Color coding as noted in the figure: EU= yellow, South Korea= red, North America= gray, and KAUST= green.

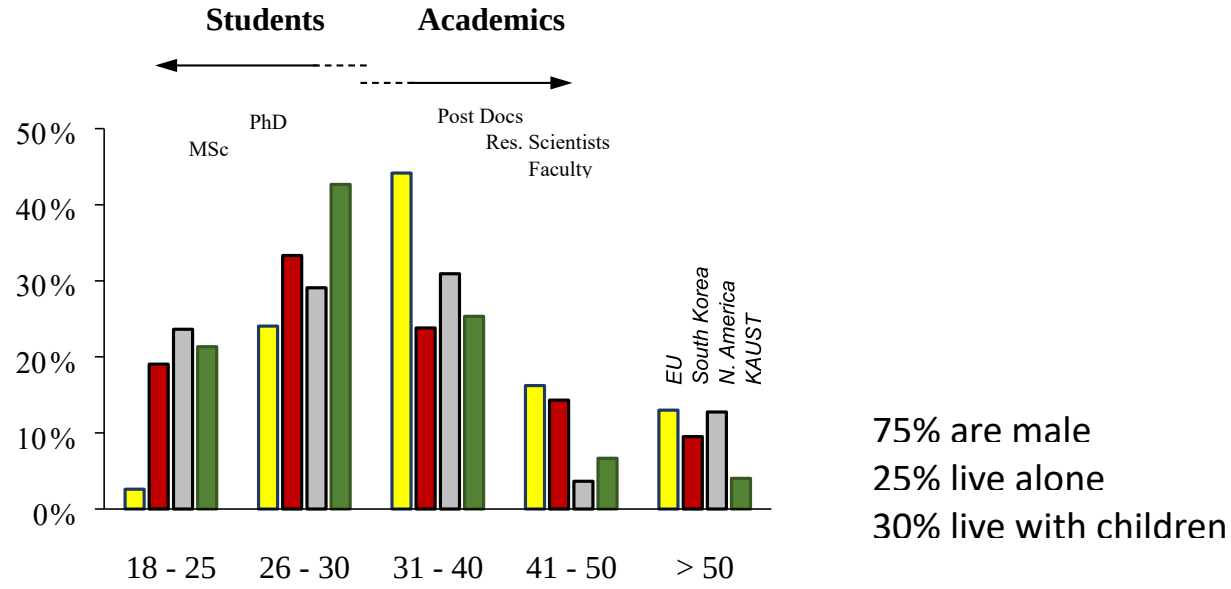
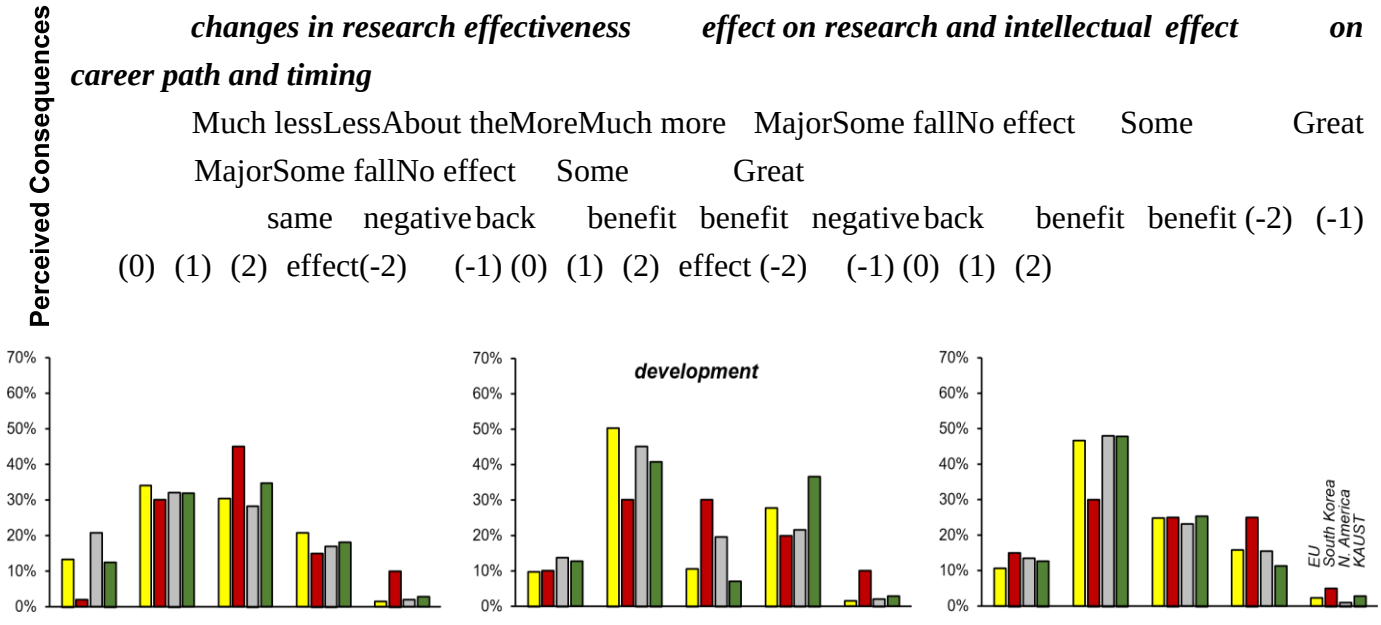


Figure 3:

Key variables emerging from the survey. Histograms in the top row show the perceived consequences of the coronavirus pandemic in terms of changes in research effectiveness, research and intellectual development, and career path and timing. The **"effect"** parameter combines an individual's answers to these questions (Appendix 1: Questions 18, 19 and 20). Histograms in the bottom row summarize responses related to daily goals and focus; these form the **"cause"** parameter (Questions 6, 7, 13 and 17). Data analysis requires converting verbal responses and ratings to a numerical scale; assigned values are shown in parenthesis but were not visible to respondents.



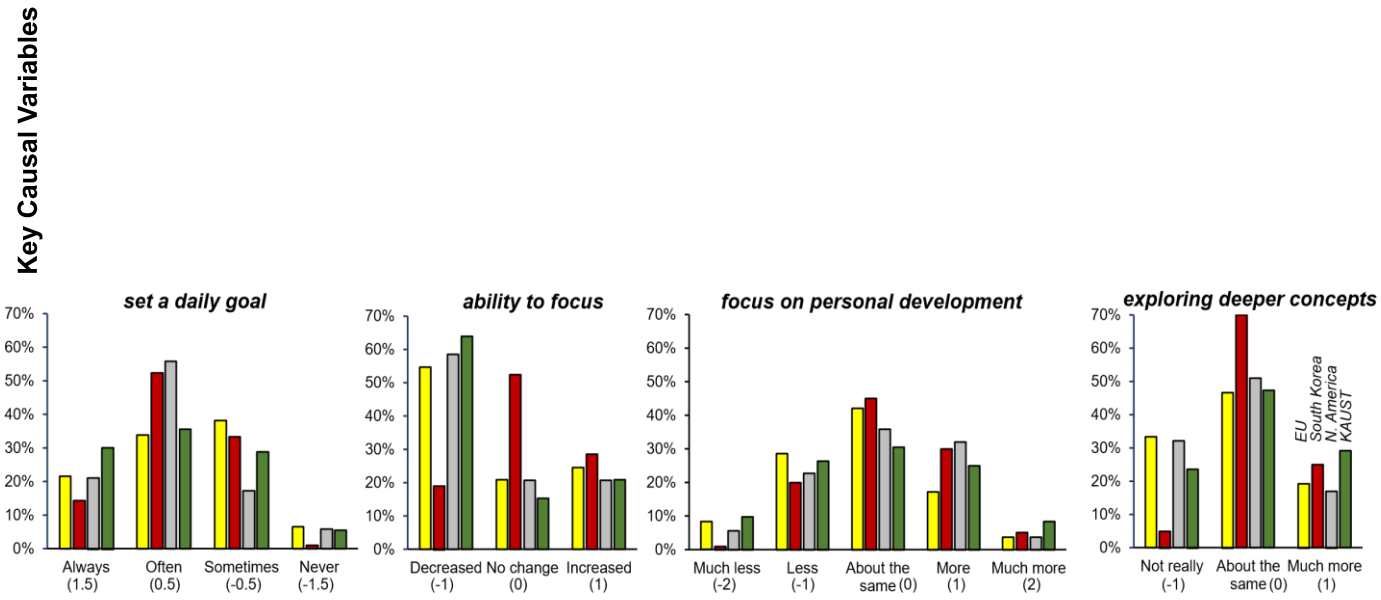


Figure 4:

The effect of causal variables on the perceived positive or negative outcomes of the pandemic. Colors indicate geographical area. EU = yellow, South Korea = red, North America = gray and KAUST = green. Data analysis requires converting verbal responses and ratings to a numerical scale, shown in parentheses in Figure 3 (not visible to respondents).

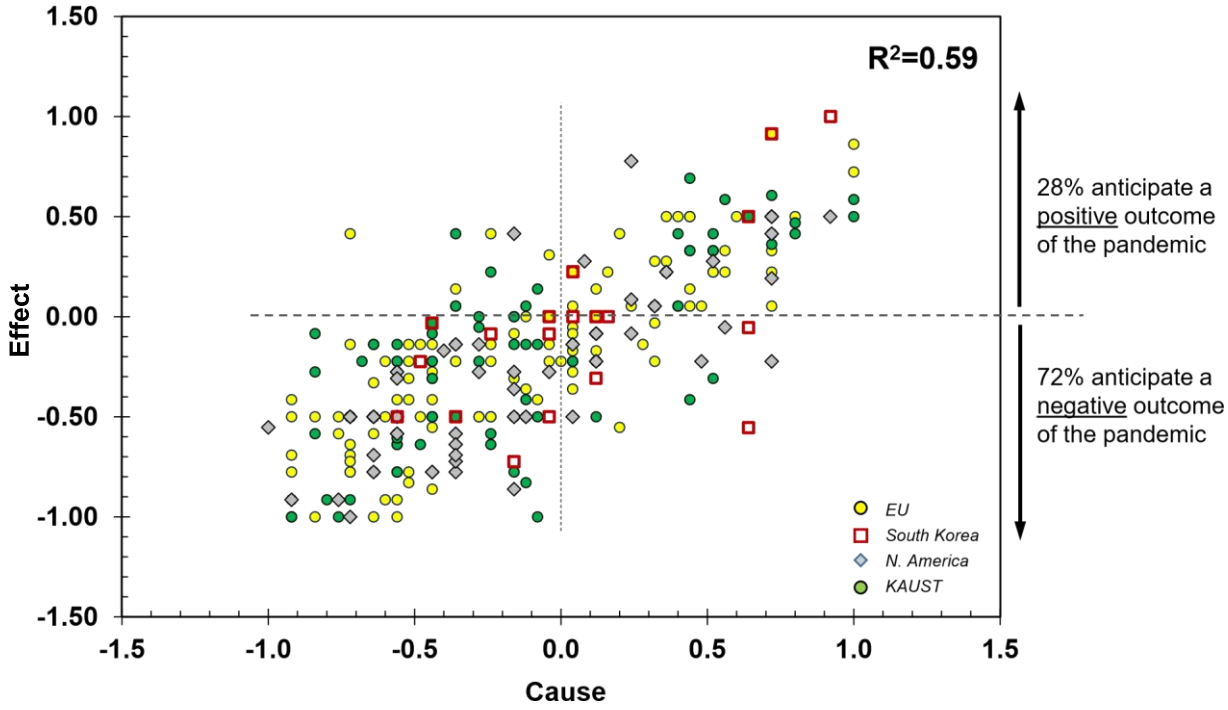


Figure 5:

Lecture style preferences for content delivered (a) in person, (b) live online, e.g., via Zoom, and (c) through prerecorded online videos, e.g., Youtube. Most respondents are KAUST graduate students who suddenly transitioned from in-class to online education during mid-March 2020.