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Fostering Individual Learning Types On Online Learning Platforms To Strengthen Students' Competencies

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ABSTRACT

The availability of video lectures and hybrid formats in higher education has increased significantly due to the COVID-19 pandemic. Predominantly, however, instructional content has simply been translated 1-to-1 into video formats regardless of effectiveness and students' needs. Interaction and diversity in content delivery were often missing. This practice paper presents an ongoing investigation on how lecture content can be presented within an online learning platform in order to meet the

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individual learning types of students and to address actual usage behaviour, potentially enabling a positive effect on learning outcomes. By creating learning paths, students can choose from different content modes, such as interactive video material, image hotspots and text material, and internalize the content according to their individual learning types. In addition, surveys are used to identify their motivation for choosing the content form as well as the extent to which this was helpful to successfully complete examination assignments. The results of the surveys will be analyzed and used for further improvements. Through the targeted use of different content modes, the positive aspects of online teaching can be furthered while strengthening the knowledge of the students individually in order to best prepare students for the complexity of a future work environment.

1 INTRODUCTION

1.1 Current situation

Facing the COVID-19 pandemic, virtual lectures and online learning have become a key element in education (Tsang et al. 2021). In this context, online learning is not a new approach; in fact, it has been used for years (Kentnor 2015). Through systematic design processes, online courses for education have been developed years ago, using technologies such as websites, learning portals, video conferencing, and mobile apps in the most efficient way. In this regard, the effectiveness of online learning has been generally demonstrated (Allen and Seaman 2013).

Nonetheless, it is important to emphasize that, until the outbreak of the pandemic, conventional academic education was mostly based on face-to-face classes and the appropriate technical equipment and flexibility were largely lacking. For many instructors, the transition to online or hybrid teaching was abrupt and under high time pressure. However, in order to maintain the continuity of higher education, it has been essential for universities and colleges to adopt online learning as a primary modality. Traditional learning methods were no longer sufficient to meet the demands of the learning process (Tsang et al. 2021). According to reports from the Technical University of Berlin, that is seen as representative for other technical universities in Germany, lecture content was often simply transferred 1-to-1 into video formats. This possibly limits interaction and feedback opportunities, lowers motivation and doesn’t sufficiently support long-term learning if not considered carefully (Avila, Maria, and Genio 2020). An initial study by the Department of Micro and Precision Devices has demonstrated the need for alternative approaches in online teaching as the demand of students have changed in response to the new circumstances effecting teaching formats prospectively (Marckwardt et al. 2022). Preparation for the real working life and the mix of subjects requires the ability to think holistically, to take initiative, to be confident, to be creative, to be a lifelong learner, to be agile, and to have appropriate methodological skills, which should be taught as key components (Kamp 2020).

To enhance these competencies, appropriate teaching approaches are needed that offer choice and flexibility, promote multi- and interdisciplinary learning, and also teach responsibility, methodological skills, and ethical foundations. In order to take

advantage of the positive developments in online teaching in recent years and to respond to the lessons learned about knowledge acquisition through online formats, it is necessary to adapt virtual presentation of information to individual learning types. A pure 1-to-1 transfer of content is not sufficient to meet the individual needs of students. Research shows a broad variety of approaches investigating important factors in the design of teaching formats, especially for online teaching. In particular, this includes the consideration of learning techniques, the learning environment, and individual characteristics of personality and learning such as the incorporation of personal learning types (Y. Wang et al. 2008). These investigations emphasize that the teaching formats need to maintain and awaken students' motivation in learning, as this correlates directly with learning results (Chang 2005).
Since the current state of research indicates that self-regulation learning and freedom of choice in learning, as well as the stimulation of curiosity through e.g., novel learning formats, significantly enhance student motivation, the aim of this research approach is to find methods strengthening these needs. The findings are also supported by our own survey data (see Fig. 2), showing that students explicitly stated that they found the free choice of learning formats particularly motivating. They tested out the formats motivated by curiosity and the possibility of self-determination in terms of time when acquiring knowledge.

Not all aspects of successful and sustainable learning can be directly addressed through the way knowledge is imparted. The possibility of self-regulation can be given by the mediation via online platforms, as well as the selection of the appropriate format for individual learning types. Vester, among others, categorizes learning types into auditory, visual, haptic, and intellectual, which are used in many educational contexts (Quilling 2015). Moreover, Kolb sees learning styles not only as individual preferences, but also as a learning cycle of an ideal learning process that includes the incorporation of concrete experiences, reflected observations, concept formation, and active experimentation based on the concept (Staemmler 2006).

To implement these teaching formats, we have drawn inspiration from Kolb's learning style model. Despite there are ongoing scientific discussions surrounding the model (Dantas and Cunha 2020), it nevertheless provides an intuitive framework for developing learning formats and enables potential comparisons with other studies. In order to have flexible options for implementation, in the approach presented, a hybrid learning platform is used in this context, which supports the processing of socially relevant topics through transdisciplinary collaboration (Marckwardt et al. 2022). As part of the learning concept of an online learning platform, the results presented here should help to identify which learning formats are best suited to support the individual needs of the students in online environments. Consequently, this practice paper presents research investigating how lecture content can be presented within an online learning platform in order to meet the individual learning types of students and to address actual usage behaviour, potentially increase learning motivation and enabling a positive effect on learning outcomes.

2 MOTIVATION AND DEVELOPMENT OF METHODOLOGY

Many new options have emerged as a result of the major teaching changes forced by the pandemic. As a result, established teaching methods are now competing with innovative formats. Both approaches have advantages and disadvantages, and together they form an even wider range of options. Lecturers are therefore confronted with the question of which formats can be maintained in which ratios, which formats support student motivation, and which optimize learning success. In order to answer these questions, surveys and test implementations have been conducted to observe and measure the actual learning behaviour and needs of students.

2.1 Motivation: Surveys on students' learning preferences

Due to the mentioned changes in teaching, it is necessary to record the current teaching situation as well as the motivation and preferences of students in order to enable efficient and long-term learning, adapted to individual needs.

Thus, a brief preliminary survey was carried out, which was used as a basis for a more detailed survey with regard to preferred formats, the motivation for selecting courses and formats, the desire and the possibility to actively participate in defining the content as well as personal learning goals and learning types. Some of the questions asked in the first survey were repeated in more detail in the second survey. Whereas the first survey offered binary response options and a simple choice of options, the second survey was much more detailed and included a rating system (0 to 5, not relevant to very important). The surveys were made available via the online learning platform ISIS and linked in the respective lectures; participation was voluntary. The coverage of the survey was 25 participants out of a total number of 5500 students at the faculty. It can be assumed that only a fraction even knew about a potential participation in the survey. The actual reach can only be roughly estimated at a few 100 students. Thus, no precise statement can be made about the actual response rate. The resulting biases are discussed in the results section. Response rates in the module-based surveys were representative, with approx. 45% participation rates. The results of the preliminary survey indicated that students would like to use a hybrid (online and presence combined) teaching format. The majority (52%) reported a preference for knowledge transfer through interactive participation and hands-on practical tasks. In addition, more than one third (36%) indicated that their motivation to learn had decreased due to isolation during the COVID-19 pandemic.

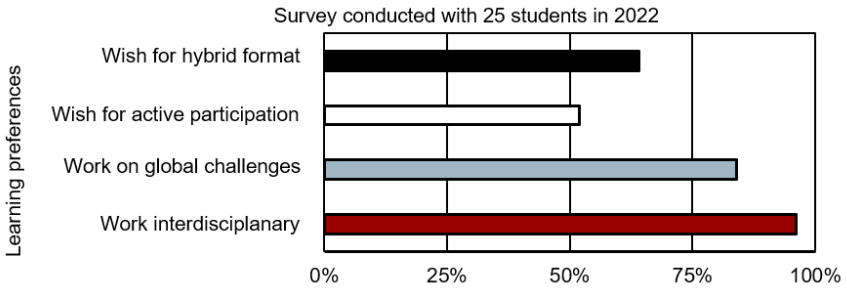

Figure 1: Preliminary survey on students' learning preferences conducted during 2022

These findings suggest that 64% of the students would embrace hybrid teaching opportunities to learn interactively in a community with the benefits of both face-to-face and online teaching. Further results showed that 96% of the students are motivated by interdisciplinary work and co-design of course content.
The second study showed that 92% of the students now choose their courses more on the basis of how well they fit in on time with other preferred lectures as well as into their private lives. This emphasizes both the need for flexibility and the significance of ensuring appropriate implementation, which aligns with the current research situation. In addition, the teaching format (4.1) was quite important to them now that there is an option. However, the possibility of getting a very good grade (2.6) was not as important as expected. This was also shown in the question about what they were proud of after completing a module, where the knowledge acquired (4.0) was more important to them than the final grade (3.3). The motivation to take part in a course increased more in courses having the hybrid format (3.9) than in the face-to-face format (3.6). Students even rated the online-only format as more demotivating (3.0). The degree to which students like to attend different course formats depends on the degree of interaction and practice. For example, they like to attend exercises, practical courses and tutorials. In comparison, lectures and project work are less popular with them. Goals of students were also analysed. 81% of students reported that they had personal learning goals for the current semester, while they focus more on hard skills than on soft skills. Nonetheless, the majority of students (55%) reported that they had never been encouraged by instructors to set personal learning goals. The other half (45%) also reported that 78% of them had not been asked about the achievement of their personal learning goals at the end of the module. It was observed that students only partially achieved their learning goals, whereas, according to them, the more interactive the teaching format was, the more likely students were to achieve their personal learning goals.
In the last part, the desires of students were analysed. The interest of the students in interaction was high. They would like to interact with the teaching staff, for example, when setting up project assignments (4.0). The desire for projects related to global challenges ranked second (3.7) after social issues (3.9), and the desire for interdisciplinarity was also high (3.8). Respondents preferred face-to-face events for interactive courses and hybrid events for mediated formats such as lectures.

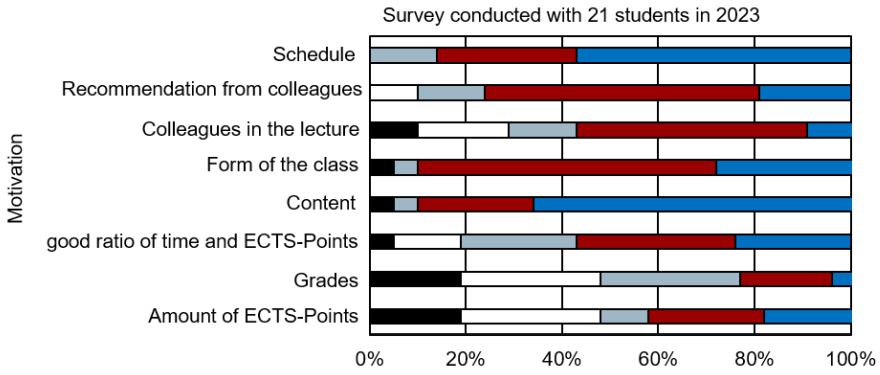

Figure 2: Second survey on students' motivation conducted during

The many options that have become more available in teaching also increase the use of individual learning types, so these were also included in the second survey. In a self-assessment, students indicated that they are most likely to learn in an auditive (4%), optical-visual (48%), haptic-kinesthetic (17%) and cognitive-intellectual way (22%). In particular, the optical-visual type, which represents the largest group, was able to benefit from the teaching formats that were partially implemented on a compulsory basis during the pandemic.

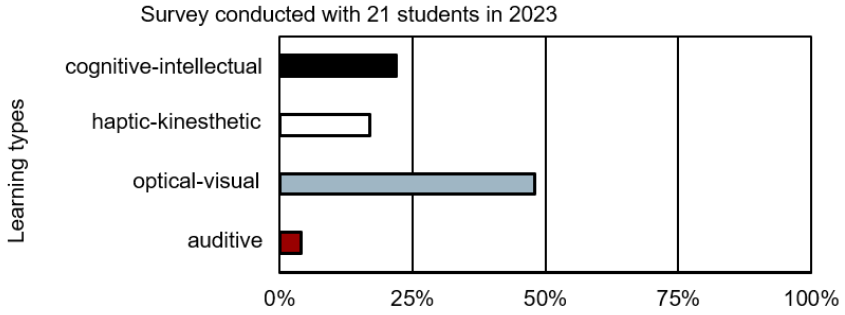

Figure 3: Second survey on learning types

In summary, it can be said that students prefer a complementary mix of teaching formats within a course module, that hybrid formats and the associated flexibility are perceived as very attractive, and that online teaching and the associated possibility of consuming a wide range of courses has also awakened a greater desire for interdisciplinary teaching.

Most of the data collected is based on surveys and self-reporting, which introduces inherent biases that cannot be completely eliminated. Due to the voluntary nature of survey participation and the limited coverage of the surveys, sampling bias cannot be entirely ruled out. While efforts were made to generate a broad sampling range, it is important to note that the demographic data predominantly represents one faculty within the university. Furthermore, the real usage data is restricted to specific module groups within the department. Additionally, common biases such as response bias exist, limiting our insight into actual behaviour and lacking contextual information. To mitigate response bias, control questions were included in the surveys, and real usage behaviour was recorded and compared with survey responses, although it should be acknowledged that real user behaviour also relies partly on self-reporting. Consequently, the overall results are limited and should be analysed individually. Nevertheless, the implemented countermeasures enable an evaluation of the methodology employed, which can be applied to other modules.

2.2 Observations after COVID-19 pandemic

Following the end of pandemic teaching restrictions and the return of students to university campuses, the Department of Micro and Precision Devices restructured established teaching methods and redundantly mixed them with newly developed methods as inverted classroom concepts. The well-established digital learning platform *"Information System for Instructors and Students (ISIS)"* at the

Technische Universität Berlin was used to test students' preferences and acceptance of different teaching formats. This platform could be used to present the learning content and to carry out the surveys on the procedure and use in accordance with data protection regulations. Since the platform is well known to the students, an easy, error-free use of the content could be assumed.
Students could decide for themselves whether to use asynchronous materials for self-study at any time or synchronous lectures at fixed times. The content was identical. Lectures were also offered in a hybrid format, allowing students to choose whether to attend online or in person. For data protection reasons, learning analytics at the TU Berlin are relatively limited, but some usable data traces are available. The data traces available only allow measuring the frequency of use of the online offerings as well as the number of different users and can be resolved in the smallest increment of one day. The videos were not downloadable, so they had to be watched online. Illegal screen casts cannot be ruled out. The sharing of materials by several students cannot be ruled out either. This imposes an indeterminable uncertainty into the data. However, it is assumed that these individual cases in the cohort size still allow significant results to be obtained.
This led to the following observations: Of the students enrolled for the exam, an average of 65% regularly used the synchronous option, with variations depending on the subject area, with the significantly larger proportion of these (70% of synchronous participants on average) preferring online participation. The use of the asynchronous option varies from 78%-84%, depending on the subject area. The number of different asynchronous users remains relatively constant throughout the semester, but the frequency of use increases, as expected, during the examination periods.
It is therefore evident that there are students with purely asynchronous learning styles (approx. 30%), students with purely synchronous learning styles (approx. 20%), and students with a mixture of the two learning styles (approx. 50%). However, the database generated by this procedure does not allow a clear separation between the groups, as some students may adapt their behaviour depending on the subject area, and no correlation with self-perceived learning type or learning success is possible. Thus, the procedure was adapted to integrate a new methodology described below.

2.3 Methodology: Development of learning paths to support different types of learning

The surveys and observations mentioned above underline the wish for teaching formats that are flexible to individual time schedules and needs contributing to self-regulated learning. Both teachers and students see the advantage of being able to give or follow lectures in this way from anywhere, which contributes positively to flexibility and individual lifestyles. Students become self-directed learners and learn both synchronously and asynchronously. However, online learning also has many disadvantages, the most important of which is that knowledge is only imparted on a theoretical basis and learners cannot apply what they have learned in practice. There is a lack of interaction and collaboration with other participants, as the content is often simply transferred 1-to-1 into video formats (Maatuk et al. 2022). Hybrid formats at

least offer consultation with the lecturer, but active interaction and practical handling of teaching material is not possible. Individual learning needs and goals are hardly taken into account, which is underlined by the survey results presented above.
Consequently, in this concept paper different methods of presenting information are derived according to existing strategies for different learning styles. Thereby, interaction, collaboration between students and a motivation for long-term learning shall be promoted. The aim of the didactic approach is to address these learning styles in the best possible way by including different online teaching formats. Not only is the consideration of individual learning styles advantageous, but the possibility of active, independent decision-making to select a particular learning format has been shown to contribute to motivation in learning (Morisano et al. 2010). Additionally, it supports the basic psychological need to perform tasks out of enjoyment (Rohlfs 2011).
To investigate the usage behaviour, the course "Processes and materials in micro- and nanotechnology" was used, as it provides a sufficiently broad cohort of students as well as a variety of online materials. In the adapted course of several lecture series, concise, thematic chapters of the video lectures were extracted and presented via branching scenarios as an inverted classroom method. Accordingly, knowledge was imparted according to the scheme listed below (see Fig. 4). After each learning unit, questions were asked about acceptance and usage behaviour. To test the approach, a lecture on thin film technology was created. First, information was presented on how to create the individual subject code, which will be needed later to match the generated information with the result of the test. The first part of the lecture on physical vapour deposition (PVD) was as usual presented as a video.
For the second part of the course on chemical vapour deposition (CVD) students could choose between different presentation formats. The first choice was also a video of the lecture slides with voice-over. The second option was an interactive video, where the video was interrupted to ask questions about the content to interact with the user. Besides, the content could be acquired by reading a provided book chapter on the topic independently. The last form, supporting the auditive learning type, consisted of listening to 21 minutes of the podcast “Chaosradio Podcast” 128 on diamonds.

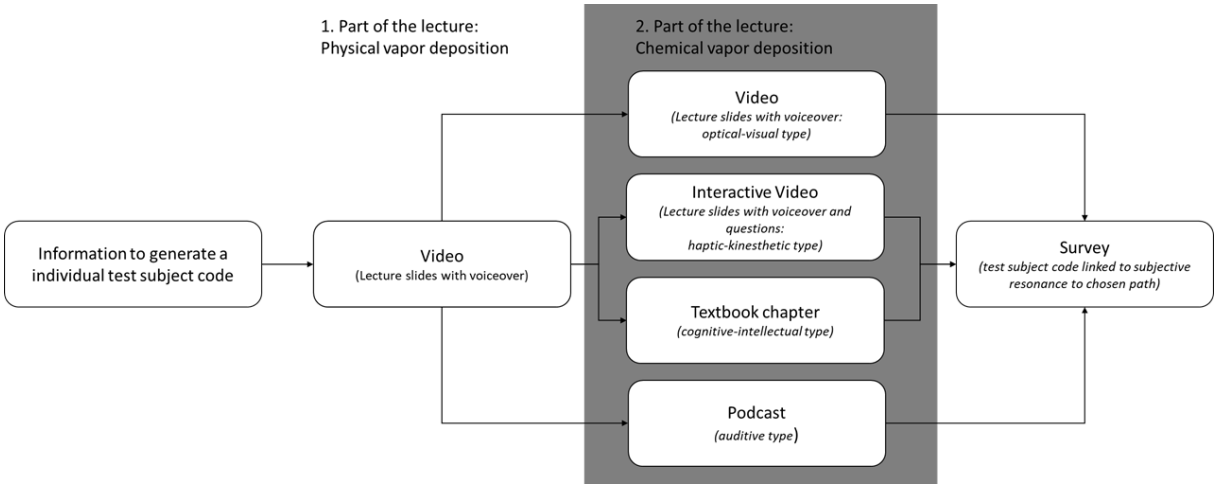

Figure 4: Scheme of lecture with branching for inverted classroom depending on the individual learning type

After the end of the lesson, a survey was conducted, which included the aforementioned questions and associated them with an anonymous respondent code. The survey on the selection of the mentioned teaching formats shows that the 18 questioned students primarily chose the interactive video (61%). The students' learning types were unevenly distributed among auditive (0%) optical-visual (33%), haptic-kinesthetic (44%), and cognitive-intellectual (22%) types. 83% of the participants indicated that the teaching format they selected was appropriate to their learning type. The remaining stated they were curious to learn and experience a different learning format. In summary, the students have essentially chosen the interactive format, which also actually fits their perceived learning type. The question remains whether this will have a positive impact on their learning outcomes in the long term.

3 SUMMARY AND ACKNOWLEDGMENTS

The past few years under pandemic conditions have shown that changes in teaching and in the way of learning can sometimes come quickly and unexpectedly. Nevertheless, the implementation in teaching has often been positive under the given conditions, but also provide great potential for the future. It is important to make skilful use of the new possibilities offered by the improved technical equipment in universities and the new mindset in the implementation of hybrid teaching formats.

The first results of this study show that students are grateful for the use of different formats and find it very engaging. The empowering approach and the interaction with the teaching material are highlighted as particularly positive. Further research with a larger number of students is needed to find out whether the teaching formats also have different effects on learning success in terms of grades and long-term knowledge building. So far, medium-term knowledge acquisition has been analysed by randomly repeated queries of previously presented lecture content. This has provided initial insights into the relationship between teaching format and individual student learning type. However, the question remains whether knowledge is retained in the long term. Based on these initial findings, it will be investigated to what extent the presentation form in online environments has a positive effect on learning effectiveness during intermediate tests and the exams. The forms of presentation that are optimally correlated with the respective learning types and successful results will in the future be integrated into the hybrid learning platform described in (Marckwardt et al. 2022). For this purpose, exams at the end of the semester will be used to check whether students who have primarily used teaching formats that are positively correlated with their learning type outperform their fellow students. This analysis is already being prepared for the current semester.

Above all, long-term learning and drawing connections through interaction with the learning material, critical reflection, and an understanding of how best to acquire knowledge will prepare students to solve complex problems in their future professional lives. The authors would like to acknowledge the active contribution of the company The Coding Machine, specifically to Mr. Gregory Rocher and Mr. David Négrier for supporting the development of the online gathering platform.

REFERENCES

Allen, I. E., and J. Seaman. 2013. “Changing Course: Ten Years of Tracking Online Education in the United States.” *Sloan Consortium*. https://eric.ed.gov/?id=ed541571.

Avila, E. C., A. Maria, and G. J. Genio. 2020. “Motivation and Learning Strategies of Education Students in Online Learning During Pandemic.” *Psychology and Education Journal* 57 (9): 1608–14. https://www.researchgate.net/profile/ernie-avila/publication/349110320_motivation_and_learning_strategies_of_education_students_in_online_learning_during_pandemic.

Chang, M.-M. 2005. “Applying Self-Regulated Learning Strategies in a Web-Based Instruction—An Investigation of Motivation Perception.” *Computer Assisted Language Learning* 18 (3): 217–30. https://doi.org/10.1080/09588220500178939.

Dantas, L. A., and A. Cunha. 2020. “An Integrative Debate on Learning Styles and the Learning Process.” *Social Sciences & Humanities Open* 2 (1): 100017. https://doi.org/10.1016/j.ssaho.2020.100017.

Kamp, A. 2020. *Navigating the Landscape of Higher Engineering Education: Coping with Decades of Accelerating Change Ahead.* 1st ed. Delft. https://www.4tu.nl/cee/publications/navigating-the-landscape-of-higher-engineering-education-4tu.cee-web-def.pdf.

Kentnor, H. E. 2015. “Distance Education and the Evolution of Online Learning in the United States.” *Curriculum and teaching dialogue* 17 (1): 21–34.

Maatuk, A. M., E. K. Elberkawi, S. Aljawarneh, H. Rashaideh, and H. Alharbi. 2022. “The COVID-19 Pandemic and E-Learning: Challenges and Opportunities from the Perspective of Students and Instructors.” *Journal of Computing in Higher Education* 34 (1): 21–38. https://doi.org/10.1007/s12528-021-09274-2.

Marckwardt, A., S. Kühne, J. Behme, C. Bleszynski, P. Bullerdieck, T. M. Dang, M. Ghazi, and D. Oberschmidt. 2022. “Broadening Personal Competence Profiles Through Transdisciplinary Project Modules.” In *Towards a New Future in Engineering Education, New Scenarios That European Alliances of Tech Universities Open up*, edited by H.-M. Järvinen, S. Silvestre, A. Llorens, and B. Nagy, 1349–57. https://upcommons.upc.edu/handle/2117/384815.

Morisano, D., J. B. Hirsh, J. B. Peterson, R. O. Pihl, and B. M. Shore. 2010. “Setting, Elaborating, and Reflecting on Personal Goals Improves Academic Performance.” *Journal of Applied Psychology* 95 (2): 255–64. https://doi.org/10.1037/a0018478.

Rohlfs, C. 2011. “Autonomie, Kompetenz und soziale Eingebundenheit. Die Selbstbestimmungstheorie der Motivation von Deci und Ryan.” In *Bildungseinstellungen: Schule Und Formale Bildung Aus Der Perspektive Von Schülerinnen Und Schülern*, edited by C. Rohlfs. 1st ed., 93–102. Wiesbaden: VS Verlag für Sozialwissenschaften. https://link.springer.com/chapter/10.1007/978-3-531-92811-1_6.

Tsang, J., M. So, A. Chong, B. Lam, and A. Chu. 2021. “Higher Education During the Pandemic: The Predictive Factors of Learning Effectiveness in COVID-19 Online Learning.” *Education Sciences* 11 (8): 446. https://doi.org/10.3390/educsci11080446.

Wang, Y., H. Peng, R. Huang, Y. Hou, and J. Wang. 2008. “Characteristics of Distance Learners: Research on Relationships of Learning Motivation, Learning Strategy, Self-efficacy, Attribution and Learning Results.” 23 (1): 17–28. https://doi.org/10.1080/02680510701815277.