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Opportunities for Flipping the Classroom in Order to Develop Higher Order Thinking Skills (HOTs)

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Abstract

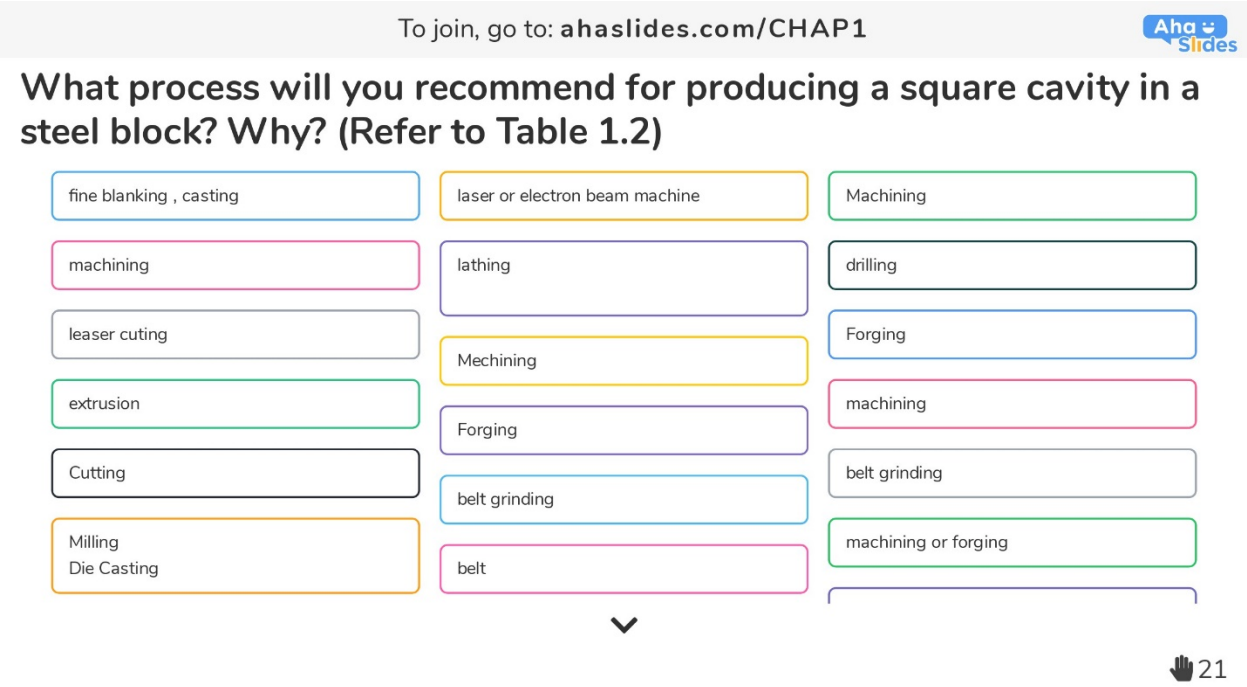
Flipping the classroom has been a dream for most instructors in higher education institutes since it involved students in reading or being familiar with a topic before the scheduled class. Students are usually reluctant to read the material prior to the lectures, so implementing a flipped class is challenging. However, the COVID-19 pandemic situation has forced institutions to switch over to remote teaching, and this has opened the opportunity for flipping the classroom. In this extended abstract, a case study of flipping the classroom for the 'Manufacturing Processes' course is shared to benefit the instructors' teaching courses related to both manufacturing and materials. The author hopes that sharing experiences in the teaching-learning process will help the teaching fraternity in general and, specifically, the global engineering education community.

Keywords
Flipped classroom, Higher order thinking skills, Active learning, Bloom's Taxonomy, Taxonomy of Significant Learning.

The current COVID 19 pandemic situation has paralyzed our routine activities, including teaching and learning in schools and higher education institutions. However, educational institutions have quickly adopted the online teaching mode, and slowly both faculty and students are getting used to it. At Sultan Qaboos University (SQU), halfway through the spring 2020 semester, the lockdown was announced, and emergency remote teaching was adopted for the second half of the semester. Since the pandemic situation is continuing, unfortunately, the Fall 2020 semester was planned as a remote teaching one. The College of Engineering (ABET-accredited programs) developed guidelines for both faculty and students in making the remote teaching effective. As part of the guideline, both synchronous and asynchronous modes of teaching and assessments are being implemented. This extended abstract shares the author's experience in implementing remote teaching in an effective way of teaching the MEIE4262 Manufacturing processes course, a prefinal course for both Mechanical and Industrial Engineering programs.

The manufacturing processes course is 3-credit, and the contact duration is 1 hour and 50 minutes twice a week. The major topics covered in the course are casting, metal forming, welding, and metrology, including testing and quality assurance. The course learning objectives, assessments, and activities were planned based on the Taxonomy of Significant Learning. The course content is mostly theoretical and less numerical, and this makes the delivery difficult primarily through any mode, either synchronous or asynchronous. Keeping the students engaged is the greatest challenge. The COVID 19 situation has facilitated to embrace the flipped classroom quickly. The contact duration of 1 hour and 50 minutes is split into two sessions for the first half reserved for the asynchronous mode. The students hear two pre-recorded lectures usually 20-25 minutes on a topic/s. This could also be done by asking students to read the material, but this is not so effective. The second half is dedicated to the synchronous mode. Typically when students are prompted to ask questions, very few respond even when face to face, and in the online mode, the response is even lower. Instead of encouraging them to ask questions, interactive presentation software 'Ahaslides' was used which has many types of questions but multiple-choice, open-ended, and word cloud is used most of the time in this course. The questions were designed to develop higher-order thinking skills (HOTs), especially analyze and evaluate. The lower levels (remember, understand, and apply) of Bloom's Taxonomy are easier to achieve by the students on their own. The difficulty arises in the HOTs, and usually, this is where instructors need to facilitate. Pure lecturing is generally considered passive, focusing on the lower levels and assuming that the students develop HOTs through the assignments and projects usually done outside the classroom. The interactive presentation forced most students to

participate and made learning exciting and fun. The questions also helped the students practice answering questions targeting the HOTs, enabling them to develop HOTs. In the assessments such as quizzes and exams, the questions are usually at the higher levels, and so the practice during the class helps the students to perform better and is not a surprise to them. A typical slide from the introduction chapter of the course is shown below for reference.



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Biography

Dr Arunachalam Ramanathan is an Associate Professor in the Mechanical and Industrial Engineering Department at the Sultan Qaboos University, Muscat, Oman. He earned B.E. in Mechanical Engineering from Annamalai University, Chidambaram, India, Master of Engineering (by research) in Manufacturing Engineering from the National University of Singapore, and Ph.D. in Manufacturing Engineering also from the National University of Singapore. Dr Arun has published journal and conference papers. He has contributed about 89 research papers in peer-reviewed journals and conferences. He has also completed seven research projects as principal investigator and one as Co-PI. His research areas include production and characterization of nanostructured materials, development of metal matrix composite, product design, and manufacturing processes: machining and casting. He also works on engineering education and has conducted a few webinars related to developing higher-order thinking skills in engineering students. Dr. Arun is also a member of the American Society for Engineering Education (ASEE) since 2015.