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Impact of Covid-19 Pandemic on Experienced Introductory STEM Instructors' Teaching Practices

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Abstract

Professional development for STEM instructors and facilitating change in their instruction requires understanding current practices along with what motivates or causes them to change their teaching practice. Teaching during the Covid-19 pandemic caused a lot of change in how courses were delivered in-person or online, but it also provided opportunities for instructors to change the teaching method used in the courses, potentially shifting towards more student-centered practices. Some commonly cited barriers to faculty changes were removed or lowered during this time and instructors had to think about their teaching due to the nature of the pandemic. Opportunity for change was present which could provide lessons for professional development and STEM reform efforts. This article reports on the analysis of experienced introductory STEM instructors' syllabi before, during, and after the full Covid-19 pandemic academic year 2020-21. Focus group interviews were also conducted to explore how teaching was impacted by the Covid-19 pandemic. Findings suggest that little changed in instructional strategies, and that the experience likely reinforced teaching practices from prior to Covid. There was no indication of intent to improve or change instruction in anyway. Take aways for professional development and teaching reform with experienced STEM faculty are discussed.

Keywords: Faculty change, Covid-19, STEM Instruction, Instructional Change

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There are numerous efforts, supported by research, to change teaching practices in higher education to be more active and inclusive of all students in the Science, Technology, Engineering and Mathematics (STEM) disciplines (Dewsbury et al., 2022; Freeman et al., 2014; Theobald et al., 2020). However faculty have continued to use mainly traditional, passive teaching strategies within these classes (Stains et al., 2018). Barriers to changing their teaching practice often cited by STEM faculty include limited time to instill the change, their teaching practice not valued as part of their job, and relatedly a lack of a culture of support to instill the change (Henderson et al., 2012; Jacobson & Cole, 2020; Sturtevant & Wheeler, 2019). In addition, if instructors are content with their pedagogy and student success, they will not perceive a need to change their practices, but discontentment with their pedagogy can lead to changing their practice (Southerland et al., 2011). Instructors who feel supported in their attempts to change their teaching practice (Bathgate

et al., 2019), along with discontentment about their teaching and the need to change their practice (Henderson et al., 2011; Southerland et al., 2011) are in an environment in which teaching change can occur. The Covid-19 pandemic teaching, especially in the 2020-21 academic year, potentially provided this environment to invoke change in STEM instructors' teaching. By its very nature there was new environmental features for the classes, class structures, and support systems. All of these can be change agents (Borrego & Henderson, 2014), and the reflecting on their teaching during this time could have led to discontentment, and thus to change (Carlson et al., 2019). Because instructors had no choice to go online and interrupt their normal teaching practices, pandemic teaching might have led to instructional change in their teaching as they returned to 'normal.'

With some conditions supportive of teaching change during the Covid-19 pandemic, the questions become: Did it inspire change for instructors, specifically experienced instructors?, And in what way? Given the importance of introductory STEM courses in students' continued pursuit of or initial interest in STEM majors (Graham et al., 2013) and the general resistance of these courses to reformed teaching practices (Stains et al., 2018), the impact of the Covid-19 teaching on these courses specifically was of interest. Could the pandemic help motivate lasting change in introductory STEM teaching? Lessons from the impact of the pandemic on teaching practice can be used for faculty professional development and our understanding of how to support and inspire instructional change among collegiate STEM instructors. This article provides a description of the impact of the Covid-19 pandemic on the teaching practices of experienced introductory STEM instructors at one Midwestern public university, R2: Doctoral Universities – High research activity classified (The Carnegie Classification of Institutions of Higher Education, n.d.), to better understand how enforced sudden change impacted teaching practices in introductory STEM courses of experienced instructors.

Context

Like most institutions, in March 2020 the university shifted all courses online mid-semester and finished the semester online and away from campus. Due to social distancing requirements in Fall 2020, more than 80% of courses shifted to completely online courses for the semester. This declined some in Spring 2021 with more smaller classes choosing some version of a blended or hybrid course, but a large majority of the courses offered were still online, especially at the introductory level. In Fall 2021, social distancing requirements were lifted for classrooms and classes could meet in person again with little restriction on spacing, but masking was required. There were still options to teach courses online or with a blended method, but a large majority of courses returned to their pre-covid meeting structure.

Like many places, numerous additional opportunities for professional development were available to instructors in Summer 2020 and Fall 2020, and even still in Spring 2021, though this semester was closer to the typical number of professional learning opportunities available to instructors. Many of these opportunities involved learning technologies like Zoom, recording and creating videos, or other educational technologies. However, this was not the sole focus of the professional learning; some mixed the technology with the teaching strategy, e.g. incorporating groupwork or group discussions in an online course, while others focused mainly on teaching strategies that might help with the difficulties seen in an online course, e.g. strategies for alternative assessments. There were opportunities for instructors to learn through formal campus professional development workshops/courses as well as through informal groups and resources, which had not been available previously. In addition, some potential barriers to change were removed, including

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the waiving of the use of student surveys as an evaluation of teaching and a 'stop the clock' options for all in tenure-track positions.

Methods

With Institutional Review Board (IRB) approval, a survey was sent out through email to all introductory STEM instructors at the institution who had taught the same introductory STEM course prior to the Spring 2020 semester, during the 2020-2021 academic year (pandemic teaching), and teaching it in Fall 2021 (return to 'normal' semester). Because the course needed to be taught by the same instructor over this period, it significantly limited the pool of instructors compared to the total number of introductory STEM instructors. The short survey had demographic questions, an assessment practice question, and then asked the participant to attach syllabi from the three semesters. They were also asked if they were willing to participate in a follow-up focus group interview. In addition to collecting syllabi through the survey, requests were made to each STEM department for the syllabi for the semesters in question. Syllabi from the three focus time periods instructed by the same person each semester were located for 14 introductory STEM courses (N =14) including the disciplines of biology, chemistry, geology, physics, agriculture, accounting, and mathematics. Instructors of these courses included both tenure-track and instructional (non-tenure track) faculty.

From the survey volunteers, focus group interviews were conducted with six instructors in mid-November. The semi-structured interviews occurred in pairs through Zoom lasting 30-45 minutes. Only two of the interviewees were from the same department, and they were not interviewed together. Five of the six interviewees were instructional (non-tenure track) faculty; but all had more than five years teaching experience at the collegiate level. The open-ended interview questions asked the instructors to talk about their teaching during the pandemic and in the current semester, including changes they made and why or things they kept and why. They were also asked what impact they thought the Covid-19 pandemic had on their teaching. Focus group volunteers received a $50 gift card for their time.

Data Analysis

The syllabi were analyzed using the *Measuring the Promise* syllabi rubric (Palmer et al., 2014). Using the components present in the syllabus, this rubric provides a score for the syllabus, categorizing the syllabus as content-focused (0-16 points), transitional (17-30 points), or learner-focused (31-46). As Palmer et al. states, this score is indicative of the syllabus not necessarily the classroom practices. Each syllabus was scored independently then scores were collected and compared by course. In addition, after scoring for each course, a list of differences in assignments, procedures, objectives, scoring, and any other part of the syllabus was created, keeping track of the changes by semester using the pre-pandemic syllabus as the 'baseline' for the course.

Focus group interviews were audio recorded and transcribed verbatim for analysis. The transcripts were read and a constant comparative method for coding was used to identify categories or codes for the statements from the interviewees (Maykut & Morehouse, 1994). The codes which emerged included technology/technology use, student engagement, student attendance, teaching methodologies, and student expectations.

Results

Syllabi from fourteen (N=14) introductory STEM courses taught by the same instructor prior to the Covid-19 pandemic (Fall 2019 or prior), during pandemic teaching restrictions (2020-2021 academic year), and in the return to 'normal' semester (Fall 2021) were collected.

Course Meeting Structure Changes

All the courses were taught in person prior to the pandemic, ranging in size from 20-25 person sections to large lectures with 50 - 300 students. Some of large lectures had a separate smaller lab section once a week but was considered part of the course. Since not all courses had labs associated with them, this laboratory aspect of the courses was not examined in this study. As mentioned, during the 2020-21 academic year (pandemic teaching) social distancing placed limitations on the number of people allowed in rooms, thus all of these courses, no matter what size, shifted fully online. Five courses (36%) met synchronously online during their scheduled times, three courses (21%) shifted to completely asynchronous courses with no scheduled meeting times for the course, and five courses (36%) shifted to recorded lectures with one weekly synchronous online discussion or 'work time' scheduled. There was one course for which the structure of the course was not clear from the syllabus. During Fall 2021, all courses could return to 'normal' which meant they could resume in person with no limitation on number of people (masks required) in the classroom. Twelve of the fourteen (86%) returned to their original pre-pandemic structure, meeting in person at the scheduled times. One course stayed fully online as it had been during the 2020-21 academic year, and one indicated it would start online for the first three weeks, and then shift to in person lectures. Thus, for the most part by Fall 2021 the introductory STEM courses collected returned to the pre-pandemic course meeting structure.

Course Activities Changes

When these syllabi were scored with the *Measuring the Promise* rubric (Palmer et al., 2014), only one of the courses shifted categories from transitional to learner-focused for all three time periods (See Table 1). This course had a high score prior to the 2020-21 school year and added a more detailed and specific course schedule to the syllabus bumping its score higher and into the next category.

Table 1

Summary of Category Scores for Collected Syllabi by Academic Year

	Content-Focused (0-16 pts)	Transitional (17-30 points)	Learner-Focused (31-46 pts)
Fall 2019 or prior	1	11	2
2020-21 year (Covid teaching)	1	10	3
Fall 2021 semester (Return to 'normal')	1	11	2

Note. N = 14 syllabi for each year. The numbers in each category represent the same syllabi. Only 1 course's syllabus shifted categories over each academic year.

This was a similar change for most of the syllabi. Most of the courses changed scores by 2 or 3 points due to the addition or removal of a course calendar/schedule from the syllabus or the

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change in assessments (typically the number) in their courses, but this was not enough to change their categorization. Comparing raw scores from prior to the pandemic (Fall 2019) to the return to normal semester (Fall 2021), 5 of the 14 scores (36%) lowered 1-3 points, 3 (21%) had no change in score, and 6 (43%) increased their raw scores by 1-4 points. As seen in Table 1, most courses were in the transitional category before the Covid-19 pandemic, so there was opportunity to become more learner-focused, but based on what was given on the syllabi, they did not significantly (>4 points) change. Almost the same number reduced their scores as improved it, but again not by enough to change categories and suggest a change in the overall focus (content or learner) of the course.

In terms of specific changes made to the courses as evident in the syllabi, the consistent change that was seen across all the courses was the distribution of points over course assessments. Nine courses (64%) changed the points structure for the course during the 2020-21 school year, reducing the portion of the total points in the course which come from exams; exams were less determinate of the course grade by 5% to 20%. This change however did not last; only 3 out of the 9 kept the same points structure in Fall 2021, the other 6 changed again increasing the portion of the course grade from exams. However, they were all still below the pre-pandemic level. Three of the courses (21%) removed exams all together during the 2020-21 school year replacing them with papers or weekly quizzes, but all three returned to exams in Fall 2021. Most of the changes made in the 2020-21 academic year that were sustained into Fall 2021 were minor and related to technology. For example, students started turning in homework online which continued, or two extra homework assignments were added in the semester (and thus typically more opportunity to drop the lowest scores). It was not a change in the assignment or requirements for the course. Language or the tool used might have shifted slightly as well; for example, one course went from calling them units to modules and a switch in the type of "clicker" being used by students to collect formative assessment data was present in another.

Focus Group Interviews

The focus group interviews (N= 6) provided some clarity and details to the syllabi review and the impact of 2020-21 school year teaching on their teaching practices. As mentioned above across the three focus groups, the instructors commented on topics of technology/technology use, student engagement, student attendance, teaching methodologies, and student expectations. All six instructors discussed a piece of new technology they had learned and were continuing to use in their classes (e.g., recording lectures or online homework system). Three of the six discussed a technology they learned that was helping with students' accessibility to course materials (e.g., a simulation that replaced an activity that was continuing to be used for absent students or as extra engagement for students who wanted it). None of the instructors mentioned the technology changing how they approached teaching or what they did with their students; the technologies just helped them do what they had been doing and "getting it" to the students. They all saw these technology skills and available technology resources they now had as a positive outcome of Covid-19.

The biggest topic the instructors discussed in all the focus groups was student engagement in classes and student attendance. All six instructors agreed that student engagement in their courses during 2020-21 school year was extremely poor overall and they were not seeing much change during the Fall 2021 academic year; attendance was down, with almost all (4) explicitly stating or agreeing that it was the worst they had seen in their careers. When it came to questions about how it was impacting their teaching practices or what they saw in the future for their teaching as a

result, only 1 of the 6 indicated they were considering any changes to their teaching because of the pandemic teaching experiences: "It's going to change a lot how I teach the gen ed courses for sure." He went on to mention trying to create a more problem-based course in future semesters as the plan. The rest indicated that it provided support for what they had been doing prior to the pandemic was what they should be doing in the course: "It did cement my belief in the way that I teach this class" or the changes mentioned were rather minor detail of content and not larger structure: "so I created PowerPoints again, which were completely from scratch, so I really had to re-, I had to look at every class session, kind of with fresh eyes." Other than the single instructor, no one indicated that they had changed or plan to make significant changes in the way they taught or approached their introductory STEM course, nor did they indicate that they saw a need to change it.[1]

Limitations

As mentioned previously, due to the focus on experienced instructors, introductory STEM courses, and a single university, the data sources for this study are limited and thus may not apply broadly. In addition, the research depended on written syllabi and teacher reported descriptions of their teaching practices to understand the classrooms; instruction was never directly observed. Reported practices might be different from what occurred in classes. However, the sample does include a range of experienced instructors across numerous disciplines and syllabi; as syllabi are 'contracts with students', they tend to capture at least the requirements that lead to course grades. Finally, this study looked at teaching immediately following the return to 'normal' teaching from the Covid-19 pandemic, but it could take longer for the pandemic teaching experience to impact teaching.

Discussion

As described above, the Covid-19 pandemic did not significantly change the teaching of introductory STEM courses by experienced instructors when compared to their pre-Covid teaching practices. Despite reduction of some barriers (e.g., student evaluations not used, time given for teaching) and greater opportunity for professional development, the instructors continued their courses as they had; they just learned a new piece or two of technology to help them do what they were already doing in their classes (e.g., technology to collect and grade homework rather than on paper or technology to record a lecture). They could have added flipped classroom methodologies, replaced exams for more authentic forms of assessments, or other active learning strategies and structures shown to improve student learning in STEM (Freeman et al., 2014), but they did not and did not indicate that they even were wanting to try it in a partial format moving forward. As another change they could have even added metacognitive strategies or strategies shown to improve student success (McGuire, 2015) after their students struggled during the full pandemic teaching year, but again there was no indication that they did this or planned to. There were hints of changes to practice towards more methods shown to support all students. For example, removal of exams or reduction of percentage of the grade which comes from exams can support all students, but these changes did not stick. They returned to pre-pandemic teaching practices or close to it. For the participants in this study, with the exception on one interviewee, there does not seem to have been

[1] Issues with cheating were mentioned in two of the three focus group sessions, but it never became a significant topic of conversation. An instructor mentioned it, another commented on it, and then they moved on in the conversation.

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enough pedagogical discontentment (Southerland et al., 2011) or proper conditions for known strategies that support STEM teaching change (Borrego & Henderson, 2014), like changes in policy, to cause a change in the instructors' teaching practices. In fact, the focus group interviews suggest that for many experienced instructors the experience teaching during Covid reinforced their current teaching strategies rather than challenged them, which could be problematic for future change especially if current practices lack much active learning.

While there were opportunities for teaching change given the environment and reduction in barriers cause by teaching during the Covid-19 pandemic, the other conditions of life and teaching during the Covid-19 pandemic may have brought up other barriers to teaching change (Musgrave, 2022). In addition, while barriers were removed to support teaching change, much of the work was still on the individual instructor due to the nature of the pandemic itself. The professional development was on Zoom, and the development of learning communities, again unless on Zoom, was halted. So while there was organizational support, there may not have been community for the support, and teaching change often needs community, stagnating if it must come from individual instructors (Reinholz et al., 2021; Sturtevant & Wheeler, 2019). And change is hard, especially in higher education STEM (Reinholz et al., 2021; Stains et al., 2018). That no change was seen for these instructors is understandable, but that does not mean we should not learn from the experience.

Implications

This study provides evidence that evidence-based strategies to support teaching change such as those suggested by Borrego and Henderson (2014) must be implemented in the right conditions and likely without sudden mandates or upheavals if they are going to stay. The upheaval of Covid-19 had these experienced instructors looking for ways to do what they were already doing in the class, only now aided with technology, and convinced them that what they were doing was what they should have been doing. We likely need to motivate STEM instructors and help them find a reason to improve or change their teaching in the best of times, rather than the worst of times.

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