PERSONAS OF STEM STUDENTS COMPLETING ONLINE INSTRUCTIONS DURING THE COVID-19 PANDEMIC

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ABSTRACT

During the COVID-19 pandemic, instructors quickly transitioned to online teaching to protect themselves and their students. Due to this abrupt transition and lack of communication between instructor and student, instructors had little time to create online teaching methods that successfully adapt and teach the material to best meet the student's needs. Some students did well with online teaching methods, while others seemed to struggle to engage with the material in classes. Without immediate face-to-face feedback from students, we believe that background information such as learning styles, goals, motivations, and expectations of the potential students- will help teachers improve and increase classroom engagement and comprehension. We surveyed and interviewed STEM introductory-level courses online to collect data to create personas in STEM students. Personas are "life-like models whose characteristics are driven by the various goals and motivations of real or potential users." We used persona methodology to survey the diverse learning group in a STEM classroom to create four personas found in STEM classrooms. These personas represent real-life students enrolling in introductory STEM classrooms, allowing instructors to use these personas as a novel tool to design online courses that better engage undergraduate students across STEM disciplines.

Keywords: Online instructions, COVID-19 pandemic, Pandemic instructions, STEM instruction, Student personas

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INTRODUCTION

In early March 2020, due to the COVID-19 pandemic, many colleges and universities quickly transitioned their in-person instruction to purely virtual learning or a mix of virtual and in-person teaching. This sudden transition was initially described as a temporary shift in instruction in response to the pandemic circumstances. Therefore, it is appropriate to describe pandemic teaching methods as emergency remote teaching (ERT), vastly different from the established, well-planned online instruction practices standard in undergraduate institutions. As a result of this sudden transition, regardless of the institution's size or the instructor's years of teaching experience, most instructors were left unprepared. Furthermore, instruction during the pandemic posed significant challenges to students. While some students seemed to grasp online teaching, many students did not seem to be engaging in the virtual classroom. In the worst-case scenario, some students may not be present at all, while others may be present but not participating. Research suggests that online learning during the pandemic has appeared to cause increased stress for students and decreased class comprehension (Zagallo 2019).

Pandemic's Impact on STEM Instructions: Studying subjects such as science, technology, engineering, and mathematics (STEM) is essential because it creates critical thinkers, increases science literacy, and enables the next generation of innovators because problem-solving is a crucial part of the STEM educational process (Hafni 2020). Furthermore, students' comprehension of undergraduate introductory-level STEM courses is vital because such courses form the foundation for more advanced courses in the future. In addition, the US Department of Education (U.S. Department of Education 2022) emphasizes the importance of building students' skills, content knowledge, and fluency in STEM fields to meet the evolving workforce demands. Therefore, the students need to complete STEM

courses equipped with the capacity for a career in science, technology, mathematics, and everyday decision-making.

While all disciplines faced their own challenges during the pandemic, its impact on STEM instruction was significant. However, the challenges associated with STEM instruction did not begin during the pandemic. Even before the pandemic, both students and instructors faced numerous challenges in STEM education. Instructors constantly struggled with their workload, the material, and instruction methods, often negatively impacting students' interest in STEM subjects. To combat the increasing lack of interest, research shows that STEM courses need changes in teaching methods like using active learning environments, “hands-on" materials, and a more explicit connection to daily life (Freeman 2014). During the pandemic, the lack of experience with online teaching methods, less time to prepare, and difficulties in accessing resources resulted in a significant challenge for students: independently connecting what they learn in the classroom to what happens in the real world.

Moreover, the COVID-19 pandemic has completely changed how instructors and students approach teaching and learning. Instead of working as a group within the physical classroom, instructors and students now must sit in front of computers to participate in online learning. Student engagement is reported to benefit student learning and performance (Beichner 2008). However, in online classes, this lack of participation has a negative impact on students' performance in the course. Further complicating this situation, instructors can take two approaches when preparing to create their education plan. First, they can teach their own way regardless of whether the students understand the material. Second, instructors can prepare their educational plans based on past experiences. Usually, instructors can adjust their plans as they proceed based on student feedback, often derived from student questions and facial/gestural expressions in face-to-face classrooms.

However, instructors do not receive much student feedback with the current online instruction mode. The pandemic-related ERT has caused instructors to plan their lessons without students in the classroom and without feedback. As a result, the instructors cannot effectively increase comprehension in their classrooms because they do not know their individual students' learning habits and how these affect their participation, goals, motivations, and expectations.

Solution: The Personas: Instructors teaching online need support in creating a classroom that incorporates active learning, inclusivity, and a collaborative environment in which the students learn to "use models, simulations, and quantitative reasoning; and communicate their understanding in collaborative teams and to the public" (Freeman 2014; Hasan and Bao 2020). With minimal immediate feedback from students, we believe that access to students' background information, such as their learning styles, goals, motivations, and expectations, will help instructors improve their online teaching methods and lesson plans, which will, consequently, increase student comprehension in classrooms. In this case, personas can help identify the students' background information and needs, allowing instructors to create plans and maintain a classroom that effectively implements those plans.

Personas, otherwise known as student models in education research, are important in education because they can anonymously represent a diverse group of students (Huynh 2021). This allows for instructors to aid individual students in their motivations and attitudes toward specific topics in classrooms while also meeting the collective needs of the classroom. The anonymity of student models allows students to express their needs to the instructors without fear of judgment (Madsen 2014). Personas and building student models can be used as a tool to help create instructional plans that cater to the individual needs of the students. “Personas are fictional characters representing key characteristics" (Zagallo 2019; Pruitt and Adlin 2010), such as the goals and motivations of different user types.

Personas are widely used in the marketing and design fields to help create realistic representations of users that encapsulate potential users' needs and goals for the product. In this study, the users are undergraduate STEM students completing online instruction during the pandemic. We can use a similar method in education to develop personas that encapsulate students' needs and goals. Personas can aid instructors in capturing the critical discriminating features across students in a classroom, which allows them to create plans that encompass all students efficiently. This allows for better comprehension of the material in online STEM classes.

METHODOLOGY

This research was carried out at a large public research university in the southeastern United States. The data for this study was collected from introductory-level STEM courses in the fall 2020 and spring 2021 semesters. Overall, in both semesters, we collected 1,802 survey responses; we collected survey responses from 19 STEM courses, although we had the opportunity to collect data from five non-physics STEM courses. Approximately 26% of our survey responses represented the non-physics courses. The survey response rate for non-physics STEM courses was approximately 42% and for the physics courses was about 52.6%. This may be because a high percentage of physics instructors offered partial credit for completing the survey, while a lower percentage of non-physics instructors did. While online surveys were the primary data source, we conducted follow-up Zoom interviews.

In our online surveys, we asked questions such as *"In your synchronous zoom lectures, if the instructor often used zoom breakout rooms to do group activities. What features did you use during the zoom breakout rooms?".* The surveys focused on how the online aspect of classes affected students and constructed the personas. In the surveys, we identified patterns through thematic analysis, culminating in four distinct personas. After the

surveys, the interviews allowed us to see how the population of STEM students would fit into these personas. Participation in these Zoom interviews was voluntary and formed the second step of the students' survey.

The survey, built in the Qualtrics environment, included scaled, multiple-choice and yes-no questions. The survey was delivered to students in both semesters. After examining survey responses from the fall 2020 semester, we decided that, along with the survey, we needed another channel to collect further information. As a result, we conducted surveys and Zoom interviews in the spring 2021 semester. While the survey format looked similar to that used in the fall of 2020, researchers developed follow-up questions based on student responses to the previous semester's survey responses. We conducted online interviews through Zoom, which allowed for safe data gathering with COVID precautions. We collected interview data through ethnographic interviews of essential consultants to compile the data into four fictional personas compared to the base personas created through the survey data. We asked questions such as *"Talk to me about your study habits?"* and *"Do you like group work?"*.

In our analysis, each persona consisted of ten criteria questions that were consistent for each interview. These ten criteria questions dealt with topics ranging from grades and studying habits based on student goals, motivations, and actions to creating realistic personas representing undergraduate STEM students completing online instruction during the pandemic. After establishing the personas through our surveys, we asked this set of open and closed questions during each Zoom interview to decide whether the interviewee fit into one of our four personas. Then, the interviewees were grouped by the criteria found in each persona. Finally, each interviewee was assigned to one of four personas if the interviewee met seven or more criteria of that persona (Figure 1).

ANALYSIS

The survey data allowed us to create a rough draft of the personas found in the classroom, while the Zoom interview data helped us place the STEM students into these four personas presented below. Out of the ten interviews, seven of the interviewees were Sam the Studious. Three out of the ten interviewees were Sarah the Social. Sam the Studious and Sarah the Social had some overlap characteristics with Paul the Poorly Motivated.

Sam the Studious: Sam spends most of his time studying independently for his classes. He seems a little distant from the other students unless they need his help. Sam goes to the office

Persona	Study Habits	Goals	Actions
Sam the Studious 	• Likes to study alone and frequently • Not a procrastinator • No music • Learns with several methods but mainly learns by him/herself • Great time management	• Specific goals in the future • Hardworking • Wants A's	• Does not like working in a group • Introverted or in the middle
Sarah the Social 	• Likes to study with someone • Not a procrastinator • Loves music • Learns with group activities • Adequate time management	• Hardworking • Specific goals in the future • Wants good grades	• Loves group work • Extroverted
Paul the Poorly Motivated 	• Is a procrastinator • Studies the bare minimum • Loves music or shows • Does not know how he learns • Not good with time management	• Wants to pass • No long-term specific goals • Poor work ethic	• Loves group work and activities • Extroverted
Sally the Self-Conscious 	• Is a procrastinator • Studies until gives up • Stays silent • Learns best with instructive help • Adequate time management	• B student • Poor work ethic • No long-term goals	• Does like working in a group • Somewhere in the middle

Figure1: The four personas and their criteria. *(Graphics credit: https://seopressor.com/blog/how-to-create-buyer-persona/)*

hours and prepares for the tests in advance. Sam makes A's in his classes. School is extremely important to Sam, and he maintains good grades throughout the semester.

With a large class consisting of many students like Sam the Studious, the instructor should develop a lesson plan with more independent work and helpful resources available for students to teach themselves outside and inside the classroom. In addition, given that Sam prefers to work individually, the instructor could reduce the time spent in Zoom breakout rooms to talk about additional topics making it a little easier for those instructors who struggle with high course loads.

Sarah the Social: Sarah is quick to answer questions asked in class. She is not scared of being incorrect. Sarah spends most of her time with friends. Sarah studies in a group for her classes. In addition to school, friends are extremely important to Sarah. She is always there to help and talk in group activities. She goes to office hours and prepares for the tests in advance with her study group. Sarah maintains good grades throughout the semester and gets A's or B's in her classes.

Sarah the Social enjoys group discussions in class and will eagerly contribute. She learns best with group work and discussions with the class. In contrast to a class full of many Sam-like students, with a large class consisting of many students like Sarah the Social, the instructor should increase group work and lab activities and decrease independent work. The Zoom breakout rooms would work well in this type of class.

Sarah the Social works well with everyone in her group and does best with a noisy background but away from anyone who would distract her. With a large group, Sarah can become overwhelmed by all the people present and become preoccupied with the people rather than the work. Therefore, she performs and stays on task best if she is not in a large group of more than four people.

Although Sam prefers not to perform group work, Sam the Studious paired with Sarah the Social will allow for more group work, experiments, and peer learning to be conducted in class. Sam the Studious will keep Sarah the Social on task during group activities, allowing more work to be done. Sam will answer questions if no one in the class will answer but will only answer if he knows he is correct. While the Sam-Sarah combination works well with small groups, the same combination would also benefit large-group and whole-class discussions.

Paul the Poorly Motivated: School is not as important to Paul, and he spends most of his time focusing on his self-interests and entertainment. Paul waits until the last minute of the day before the test to study. Paul needs more help in classes. He enjoys group activities so that he can obtain assistance from others. He does not go to office hours. Paul's only goal is to pass the class.

Within a class full of many Paul-like students, the instructor may have to spend considerable time swapping between the Zoom breakout rooms to offer more hands-on help to students. Paul needs more one-on-one time with the instructor to increase comprehension, but unfortunately, he doesn't seem to take advantage of office hours. Paul will sit silently in class unless the instructor points to him to answer questions. Even though Paul might know the answers, most of the time, Paul does not think too hard about the question and ends up guessing the answers. He can disrupt classes by talking to other classmates closer to him or not listening during lectures.

Paul benefits most from being in a group together with Sam and Sarah. However, Paul should be watched in group work to ensure he does not take advantage of Sam the Studious or Sarah the Social.

Sally the Self-Conscious: Sally spends most of her time fretting about school. Sally studies in advance for the test, but she gives up because she thinks there is no hope. She needs more

help in class. She started off going to office hours but stopped after she felt it did not help her. Sally becomes overwhelmed when too much work is given at one time. She always passes her classes.

With a large class full of many Sally-like students, the instructor should help the student remain encouraged throughout the semester by maintaining a detailed plan with progressive steps, so Sally does not get overwhelmed. Sally would benefit from office hours with the instructor and more words of encouragement than other students. She is capable of learning the material but becomes overwhelmed with all the work and tests. Having a detailed calendar of homework and tests can help Sally stay on track and complete her work in a timely manner with less stress. Group discussions cause anxiety and stress for students like Sally the Self-Conscious. She does not like being called on, but she will answer the question if she is one hundred percent sure of her answer. She is usually correct, but she will remain silent because she isn't one hundred percent sure. In group work, Sally the Self-Conscious will remain quiet and usually perform her work independently. A high amount of group work and discussion may not be the best fit if the class consists of a majority of Sally-like students.

Although Sally the Self-Conscious spends most of her time worrying during school, being paired with Sam the Studious offers Sally some relief. Sam helps Sally not to worry whether the answer is correct or not because Sam is there to reassure her. This support allows Sally to be efficient while working accurately. At the same time, the increase in Sally's confidence benefits the whole class through group discussion and work. In contrast, Paul the Poorly Motivated is best placed in groups of two to three so that he remains responsible for a task but has support if he gets lost. Paul and Sally should not be grouped together because they will not work cohesively together. Paul will make Sally do all the work while waiting to copy her work.

DISCUSSION AND CONCLUSION

The COVID-19 pandemic has completely changed the way we approach teaching and learning. This drastic disruption has resulted in many unexpected challenges for students and instructors. The transition from face-to-face to online instruction is already complicated; however, it can be made easier with an educational plan based on the personas found within the class, which will ease students' transitions. From the instructor's perspective, access to learning styles, goals, motivations, and expectations will help them create realistic representations of potential students, ultimately enabling them to design courses to support the whole spectrum of students. From the students' standpoint, having instructors who better understand student needs and weak points will reward students because it creates a welcoming environment for all learning types.

Personas are critical to anonymously understanding a diverse group of individuals, allowing instructors to empathize and understand students before developing their lesson plans. Student models are used in other areas, such as business, to encapsulate potential buyers' wants and needs to best sell their products. Building student models in education are fundamental because it can start conversations on what changes are necessary for students to maximize their education in classrooms. Instructors want to create the best plan to help all students comprehend and engage in the material; personas are a great way to start. Personas are a helpful tool for instructors to gain perspective and access to students' learning styles, goals, motivations, and expectations. Personals also enable them to design courses to support the whole spectrum of students. From the student's standpoint, using personas allows for an educational plan tailored to individual student needs.

Each student has a way in which they best learn. This differentiation makes it difficult for instructors to reach most students and produce effective instruction. Although not all Sam the Studious personas learn the same way, the data shows that combinations of

other learning methods can increase Sam's comprehension. Sam mostly prefers solitary studying with outside resources and lectures. He learns best with a logical approach to problems. In contrast, Sarah the Social persona learns best with hands-on activities, group work, and discussion. Paul, the Poorly Motivated, is a little unsure about his best learning method; he benefits from visual learning. Further, he learns best through one-on-one time with the instructor. Similarly, Sally learns best through one-on-one time with the instructor but prefers the verbal learning style. As shown above, even without face-to-face feedback, the personas approach allows instructors to identify and incorporate different teaching methods to help diverse learners in their classrooms.

The majority of students who volunteered for follow-up Zoom interviews were physics students. If we consider only the Zoom interview data, some interviewees demonstrated an overlap between Paul the Poorly Motivated and Sam the Studious, while the majority showed Sam's characteristics. Those students with the Sam the Studious persona are more likely to undertake the additional work of interviews than Paul the Poorly Motivated and Sally the Self-conscious, which explains why the interview data have a strong bias toward Sam the Studious personas. We might see more persona variety if the Zoom meeting sample size of students were larger and represented a mix of all STEM students. Despite this limitation of only having 26% of our survey responses represent the non-physics courses, we believe these physics students represent a sufficient sample of undergraduate STEM students to generalize our findings. Further, in this study, we mainly focused on STEM courses, but this personas tool can also be used in other disciplines. This study can be improved by getting more data from other STEM courses besides physics to enhance the personas for the entire STEM field. Additionally, using personas as a tool in classrooms can be used during online learning and can also be used to enhance face-to-face learning.

Further, the pandemic has caused many students to become more reliant on themselves than their instructors and has caused an increase in procrastination. This change also affects the criteria of personas. The next step for this research would have been to conduct further Zoom interviews to obtain a more accurate representation of the personas in STEM classrooms. Although we only had a small sample of interviews to place students into our personas, the large sample size of surveys showed us the patterns to create these personas. Therefore, with a larger sample size and an incentive for doing the interviews, we could get a larger unbiased sample of STEM students to see the composition of students found in STEM classrooms. With online learning likely to end as more classes are transitioned back into in-person, we might not be able to collect such data on students' experience in online learning. However, these personas can be implemented in classrooms to create an educational plan that accurately fits students' needs, even with in-person instruction. This approach allows for classes to be catered to the students, helping them gain the necessary information efficiently and effectively while placing them in groups where they will have the best fit to complete problem-solving activities and experiments.

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