STEM Teacher Efficacy in Flipped Classrooms

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Review of the Literature
Teacher Efficacy

Teacher efficacy is defined as “the extent to which the teacher believe[s] he or she [has] the capacity to affect student performance” (Berman et al., 1977, p.137). Modern iterations of teacher efficacy are situated in social cognitive theory (SCT), and the construct has been demonstrated to be both context and subject dependent (Bandura, Bobbett, Olivier, & Ellett, 2008; Tschanne-Moran & Hoy, 2001). Ostensibly similar to Bandura’s (1977) theory of self-efficacy, where the focus lies on the outcomes for oneself, teacher efficacy differs in that it measures the belief in the ability to influence the outcomes of others (Hoy, 2000). Common to contemporary discussions of both teacher efficacy and self-efficacy are three factors affecting both constructs: experience, vicarious experience, and social persuasion (Bandura, 1977; Protheroe, 2008). Teacher efficacy is highly context dependent and subject specific (Tschanne-Moran & Hoy, 2001). Teachers may experience high levels of efficacy in a particular topic or with one group of students, but low efficacy levels with different groups or subject matter.

Although there has been recent discussion on the original basis of the theory and measurement of teacher efficacy — whether it is situated in Bandura’s (1977) theory of self-efficacy or Rotter’s (1966) locus of control — modern (post-1977) research and instrument development are firmly grounded in Bandura’s theory of self-efficacy (Dellinger et al., 2008; Klassen, Tze, Betts, & Gordon, 2011).

Researchers have concluded that the construct of teacher efficacy is multi-dimensional and that several dimensions correspond to Bandura’s self-efficacy as it relates to outcome expectancy affected by internal and external factors (Gibson & Dembo, 1984; Tschanne-Moran & Hoy, 2001). Although there is general agreement on the underlying factors of teacher efficacy, Tschanne-Moran and Hoy (2001) characterized it as “an elusive construct.” In this study, we seek to qualitatively examine teacher efficacy as it relates to these factors; mastery experience (how the teachers directly experienced the flipped classroom instructional model), vicarious experience (how the teachers understood the students’ perception of the model), and social persuasion (how the teachers viewed...
supports within the school and other teachers’ perception of the flipped classroom. Physiological factors are a component of self-efficacy (Bandura, 1997), but are not examined in this study, as they are not discussed in the extant literature related to teacher efficacy.

**Flipped Classrooms**

The first mention of the flipped classroom instructional model appeared in the literature in a paper titled “Inverting the classroom: A gateway to creating an inclusive learning environment” (Lage et al., 2000). This was the first research into flipping the classroom and focused on student and faculty perceptions in an introductory economics course at Miami University. Simultaneously, Wesley Baker (2000) was presenting a theoretical model, “The classroom flip.” Using web course management tools to become the guide by the side,” referencing Alison King’s (1993) work. Baker’s work is the start of the colloquial term “flipped classroom”. Both define the flipped classroom instructional model similarly as “events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa” (Lage et al., 2000, p. 32). Both papers stress that the advent of modern communication technologies and the Internet provide a platform for educators to present lecture material to students outside of the classroom, leaving greater time for discussion facilitation and active learning.

Although scholarly research at the K-12 level is still sparse, there is a growing body of academic and empirical research into the impact of the flipped classroom instructional model on student academic performance indicators (Bishop & Verleger, 2013). The bulk of these studies have been at the university level and have been represented by convenience samples comprised of courses taught by professors studying the effect of using a flipped classroom instructional model.

To date, the effect of using the flipped classroom instructional model on teacher efficacy has not been examined. The flipped classroom instructional model does not boast a prescribed method for the teacher to follow. Variations in technology availability and understanding of the best practices for their use in the classroom have yet to be empirically studied. Similarly, teacher understanding of and comfort with this teaching method have not been featured in the extant literature. The limited body of K–12 research in these areas presents a demonstrable need for the study of a burgeoning instructional model that is growing in popularity among educators and administrators.

**Methodology**

Research has provided evidence that teacher efficacy acts as a mediating factor for student academic and serves as a predictor of teaching success and student achievement (Cantrell et al., 2003; Gibson & Dembo, 1984). To better understand the effect of the flipped classroom instructional model on teacher efficacy levels, we utilized qualitative methodology to gain valuable insights. Since literature provides proof that student achievement is influenced by this construct, it is important to understand the underlying motivations and perceptions of teachers utilizing the flipped classroom instructional model. We do this by applying transcendental phenomenology as an analytical method to help understand the flipped classroom instructional model within the bounds of this case study (Creswell, 2007; Creswell, 2013; Moustakas, 1994).

**Participants**

Participants for this case study were volunteers from a purposefully selected group of STEM educators at a local charter high school. The group was selected both for their respective school’s STEM focus and a committed emphasis on flipped classrooms. The school’s website states their mission “is to increase access to globally competitive Science, Technology, Engineering, and Math (STEM) education for students and teachers across North Carolina...” The school’s homepage states: “Our school is built around the ‘flipped’ model of education, in which teachers deliver content knowledge outside of class so that students can practice, apply, and build on what they have begun to learn.” It is required that all teachers employ the flipped classroom instructional model and interviewing teachers must demonstrate a flipped classroom as part of the interview process.

The school’s staff directory was used to identify teachers in STEM content areas and obtain contact information. These six teachers were contacted via email. A voluntary sample of three teachers responded and agreed to participate in the study. This sample size falls within the acceptable range of three to ten participants for an exploratory case study as discussed by Creswell (2007). These teachers represented chemistry, environmental science, calculus, and engineering (technology education is not explicitly taught). Engineering is included in this study as a subject taught; however, the participating teacher who teaches both calculus and engineering does not use the flipped classroom instructional model in the engineering class, as there is no work assigned outside of class. Participating teacher demographics are displayed in Table 1 below.

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Gender</th>
<th>Education Level</th>
<th>Subject(s) taught</th>
<th>Teaching experience</th>
<th>Flipped classroom experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Female</td>
<td>Master’s</td>
<td>Chemistry</td>
<td>&lt; 20 years</td>
<td>Two years</td>
</tr>
<tr>
<td>B</td>
<td>Male</td>
<td>Master’s</td>
<td>Calculus and</td>
<td>6 years</td>
<td>Three years</td>
</tr>
<tr>
<td>C</td>
<td>Female</td>
<td>Master’s</td>
<td>Environmental</td>
<td>4 years</td>
<td>Two years</td>
</tr>
</tbody>
</table>

Table 1. Participating Teacher Demographics

**Setting**

A suburban North Carolina public charter high school was chosen for this study because of its focus on both STEM and flipped instructional practices. The school has been in operation for three years and had an enrollment level of 341 students serving grades 9–11 at the time of this study. The average classroom had 24 students with the following ethnic demographic breakdown: 8% Asian, 6% Hispanic, 6% other/multiracial, 26% Black, 54% White. Twenty-two percent of students qualified for the federal free or reduced lunch program.

The school places emphasis on ensuring teachers have all the needed resources available for satisfactory implementation of the flipped classrooms. This includes technological resources (hardware and software), professional development, and in-house technical staff. The school follows a bring-your-own-device (BYOD) model for student computer technology use. Students without their own devices may use loaner computers provided by the school. Students with no or limited Internet access are also provided time before, during, and after school to access online class resources.

**Research Questions**

The purpose of this research was to determine the effect flipped classroom instructional methods have on teacher efficacy. Flipping was a key component of the courses they taught. The research questions for the study are as follows:

1. What are STEM teachers’ perceptions of flipped class rooms?
2. How do STEM teachers’ perceptions and/or use of flipped classrooms affect their teacher efficacy to teach in a flipped classroom environment?

**Methods**

Figure 1 presents the process used for this study. This process is based on the procedures set forth by Creswell (2007; 2013) and Moustakas (1994).

Semi-structured interviews were used as the method of data collection for this study. Semi-structured interviews were deemed appropriate for this study due to their suitability for perception exploration, the ability to probe
for deeper understanding, and the varied professional experience of the participants disallowed a standardized question set (Barriball & While, 1994).

Data Gathering

Data collection for this study consisted of audio-recorded semi-structured interviews, which were then transcribed by the researcher. Semi-structured interviews were appropriate for this research study due to their ability to help gain in-depth knowledge into the perceptions of the teacher participants (de Marrais & Laplan, 2004).

Interview questions. Qualitative interview questions developed for this study were guided by the research questions framing this study. These questions are informed by the three constructs of teacher efficacy examined in this study (mastery experience, vicarious experience, and social persuasion). These questions were designed to elicit responses from the participants as to how they personally experienced the flipped classroom instructional model, how they saw other teachers use the model, and what they had been told or trained concerning flipping their classrooms. These questions were designed to be open-ended, for the participants own words were an essential component of this study (Fink, 2003). Figure 2 displays the questions developed and used as a starting point for the semi-structured interviews.

Procedure

This exploratory case study was bounded by the use of a single high school and the use of only STEM teachers using the flipped classroom instructional model. Transcendental phenomenological reduction was chosen as a method of analyzing the data collected for several reasons. The approach in this research involved studying a small number of participants, and it was deemed appropriate to study the flipped classroom instructional model as it was experienced by the participants as their perceptions were being analyzed (Creswell, 2013). Furthermore, Transcendental phenomenology considers the experience of each participant as a unique occurrence (Moustakas, 1994). Those experiences were combined and reduced to derive the “essence” of the phenomenon as experienced by the participants (Creswell, 2007; Moustakas, 1994).

Data Analysis

We coded literal words and phrases from the transcripts of each participant that appeared to hold significance as to how the participants experienced the flipped classroom instructional model (Creswell, 2007; Moustakas, 1994; Saldaña, 2012). These codes were then developed into three themes based on Bandura’s (1995) factors affecting self-efficacy. Exemplars of participant statements and the themes into which they were coded are presented in Table 2.

Once all participant interviews were coded and themes developed, textual descriptions of how each participant experienced the flipped classroom instructional model were developed as it related to each theme. These textual descriptions were condensed into a composite textual description of how the instructional model was experienced by each participant. We then wrote a structural description of the environment in which the participants teach (Creswell, 2007; Moustakas, 1994). This included school demographic information, mission, STEM focus, and required use of the flipped classroom methods of instruction. From these composite descriptions a final composite description, or “essential description,” was generated (Creswell, 2007; Moustakas, 1994). This description captures the essence of the flipped classroom instructional model as commonly experienced by the participants.

Theme Generation

Themes were determined based on the three factors affecting teacher efficacy: experience, vicarious experience, and social persuasion (Bandura, 1977; Protheroe, 2008). Codes generated from participant interview transcripts were sorted into one of these categorical themes.

Experience. Codes that related directly to the experience of the participants were categorized as experience. These included codes related to flipping the classroom,

Figure 1. Data collection and analysis process used in this study.

Figure 2. Initial interview questions for the semi-structured interviews.
technology use, success and/or failure with the flipped format, time gained in class, and reports of student experiences.

**Vicarious experience.** Codes that related to the experience of the students or other educators were categorized as vicarious experience. These included codes related to student observation, perceived student understanding of material and use of flipped format, success and/or failure of other teachers with the flipped format and technology use, and perceptions of student experiences. Students were not interviewed; rather, their experiences through the lens of the teacher were considered vicarious experiences for the purposes of this study.

**Social persuasion.** Codes that related to professional development (both formal and informal), support and resources provided by the school and its administrators, and the atmosphere/climate of the school regarding flipped classrooms were categorized as social persuasion.

**Trustworthiness**

Multiple procedures — including clarifying researcher bias, bracketing, member checking, and external auditing — were used to evaluate the trustworthiness and validity of the coding and analysis of the data (Creswell, 2007). The primary researcher and author’s understanding and opinion of the flipped classroom instructional model were written down and archived at the outset of the study as part of a validation strategy iterated by Creswell (2007). This clarification and articulation of the researcher’s biases were written to both acknowledge their existence and to serve as a reminder during data analysis for the researcher so that prior experience and bias may not color the analysis. This understanding was used to bracket (set aside the researcher’s opinions) during the data analysis component of the study.

The primary author also sent the textual descriptions for each participant’s interview to them electronically and asked them to both verify that they accurately described the participants’ experience of the flipped classroom and they were asked to clarify and correct any portions they felt did not represent their experiences accurately (Creswell, 2007). The participants all confirmed that the textual descriptions were an accurate representation of their experiences and no participants offered or suggested any changes.

A peer review process was used to ensure the findings of the study were supported by the data and process used for the collection and analysis of data (Creswell, 2007). The two reviewers were experienced researchers not directly connected to the study and were provided complete access to all study materials and reports. Regular meetings were conducted with the reviewers during the data collection and analysis phase. This review along with member checking and researcher bias clarification are three procedures detailed by Creswell (2007) as part of an eight-item validation strategy list where he recommends the use of at least two.

**Findings**

The STEM teachers interviewed for this study had high levels of observed teacher efficacy. It is important to note that teacher participants’ attitudes towards flipped

<table>
<thead>
<tr>
<th>Theme</th>
<th>Definition</th>
<th>Representative Quotation from the Participants</th>
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<tr>
<td>Mastery Experience</td>
<td>Experiences or feelings the teacher personally has or has personally observed as they relate to the teacher’s activity.</td>
<td>&quot;It frees up that really valuable class time to do things that I think makes them understand the material better.&quot; (Participant A)</td>
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<td></td>
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<td>&quot;I am spending more time walking around the room and sitting with students and working problems and going towards a deeper understanding.&quot; (Participant B)</td>
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<td>&quot;It also allows time as teachers to be there while students are working on problems to clear up misconceptions immediately instead of them having to struggle through the bulk of a work set not knowing what to do.&quot; (Participant C)</td>
</tr>
<tr>
<td>Vicarious Experience</td>
<td>Experiences or feelings the teacher has been informed of directly from their students or personally observed student behaviors.</td>
<td>&quot;They’ll go back and rewatch it and it makes so much more sense.&quot; (Participant A)</td>
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<td>&quot;They should have a greater opportunity to get the skills communicated, and then, when they’re in class they get to practice, and if they have the blank sheet of paper effect in class then guess what, they have the whole class, their classmates are there and the teacher there to get the task done.&quot; (Participant B)</td>
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<td>&quot;It increases student engagement while they’re in the classroom because they are not having to sit still and listen, they’re getting to talk with each other.&quot; (Participant C)</td>
</tr>
<tr>
<td>Social Persuasion</td>
<td>Experiences or feelings the teacher has been made aware of but did not directly observe and support received or not received from the school.</td>
<td>&quot;Watching other people talk about flipping, what worked for them, what didn’t work for them.&quot; (Participant A)</td>
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<td>&quot;I have not [completed professional development], nothing formal. I mean, we’ll have chats and talks at school during PD time but no formal training.&quot; (Participant B)</td>
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<td></td>
<td></td>
<td>&quot;I would ask for it and it would happen our school.&quot; (Participant C)</td>
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Table 2. Developed Themes and Representative Quotations
positive and negative, contributed to the teachers’ refine-
ment of how they personally employed the flipped instruc-
tional model in their classrooms. The teacher’s comfort-
level with the content also played a significant role in their decision-making related to the implementation of the model.

“I tried to do my own version of flipped classroom with the cart of laptops that we had and self-directed learning. It fell flat on its face, but that was because it was math and math teaching was not my game.” (Participant C)

“I don’t flip my engineering course] mainly because...
Students who are active participants in flipped classrooms have greater opportunities to work with and talk to other students rather than sitting and listening as a passive listener. One teacher described what they called “the blank sheet of paper effect” as a regular occurrence prior to flipping the classroom. This was described as the moment when students would leave class and attempt the homework only to sit and stare at a blank piece of paper.

Having the flipped lessons, if students are “in class they get to practice, and if they have the blank sheet of paper effect in class, they have the whole class, their classmates, and the teacher there to get the task done” (participant B).

Students are also able to re-watch videos if needed. In class, students can get assistance from teachers and students when faced with a task that presents a challenge or a struggle.

“Students tell me that they re-watch videos before tests so it’s almost like hearing the lecture twice or going to class twice. So, they’ll re-watch videos to relearn the content.” (Participant A)

As outlined by the participants, it is important that expectations for watching the videos be established as part of the course. If the teacher re-teaches a lesson because students did not watch the video at home, students are not motivated to watch the videos. Incentivizing the students to watch the videos is an important aspect as it is not repeating the video content in class because some students did not watch them at home. Student buy-in and participation are key factors for success in a flipped classroom environment.

“I think that is what makes students that watch the videos more vigilant to watch the videos because they are going to just come in and get the lesson anyways because it didn’t give them any gain. Once it got past that, I think that I’m more effective in using the tool.” (Participant C)

“The kids that do not watch videos fall behind and stay behind unless they take initiative to catch back up.” (Participant C)

Some teachers perceive deficiencies in their own technological skills when creating videos. Videos created by younger, more technologically savvy teachers have higher levels of editing and effects. Yet, videos created by less experienced teachers with respect to video editing are not motivated to watch the videos. Incentivizing the students to watch the videos is an important aspect as it is not repeating the video content in class because some students did not watch them at home. Student buy-in and participation are key factors for success in a flipped classroom environment.

A described, “the students perform very well on their end of grade test,” and “completed all the content and with time to review which [they] had never done before.”

**Theme 3: Social Persuasion**

Professional development is a key component of successfully flipping the classroom. This is provided by the school through regular professional development meetings and as needed/requested by teachers. Formal training is limited with teachers relying on peer-to-peer guidance and informal discussions of experience with flipping the classroom. This was consistent among all the teachers participating in this study.

“Watching other people talk about flipping, what worked for them, what didn’t work for them, and it is kind of content specific as well.” (Participant A)

Teachers are able to learn from each other, and while they may desire additional training into pedagogy and technical skills, teachers feel comfortable discussing their methods with each other. School administrators in the school chosen for this study are supportive and ensure resources are available for successfully flipping the classroom. This includes equipment, training, and software. There is an atmosphere of support among teachers and administrators surrounding flipped classrooms.

“If I wanted anything else, I would ask for it and it would happen our school, especially if it was for video making.” (Participant C)

Support from the school and discussions of the successes and frustrations of the implementation of the flipped classroom with other teachers appears to be a strong and consistent factor in the feelings and perception of teacher efficacy related to the flipped classroom. Feeling supported by school administration is not a novel concept in education and teaching, but seems to be of greater importance when a flipped model involving technology is involved. The success of the model in this school was attributed to the support received by teachers and exemplified by one teacher (Participant C) commenting that if any resources were needed, “I would ask for it and it would happen our school.”

**Discussion**

Participants in this study perceived the use of the method to be largely positive, which was not indicative of their perceptions prior to engagement in flipped classrooms. This was in light of increased time during class to cover material and address student misconceptions in real time. Student misconceptions also became clearer to the teachers when flipping the classroom. Teacher perceptions of flipped classrooms ranged from positive to “priceless,” revolutionizing their teaching.

The teachers perceived student use as a positive factor because students were able to stop and re-watch the video or sections of it. Students who were absent were able to stay abreast on content delivery, and those wishing to review lectures before exams could revisit the online videos. A concern raised centered on students neglecting to watch the videos outside of class which led to them being more likely to get, and stay, behind. Participants addressed this as a demonstrable need to incentivize students to participate actively in out-of-class activities and to provide these mechanisms from the outset of class to ensure this participation.

A common theme among all participants was time. While positive gains in classroom time spent with students and on curricula were reported, the extra time spent planning and creating online lectures was remarkable. Teachers reported that preparing for a course took more time especially in the first year of teaching the curriculum as a flipped class. Participants also reported that the time spent in the first year of a course was rewarded in subsequent years as a library of content was built. While videos covering course content is readily available online, it was the opinion of the participants that teacher-made videos are superior. It should be noted that time management and time constraints continue to be a major concern for all teachers and this is exacerbated when considering a flipped classroom environment. However, it was clear that participants for this study viewed the extra time committed as a trade-off for increased student understanding.

**Implications**

During the analysis of data, a recurring theme emerged that may have further implications for research in the area of teacher efficacy particularly as it pertains to flipped classrooms. Time proved to be a consistent factor in courses with flipped instruction both in time spent preparing and instructional time gained. The amount of time spent planning and creating videos for use in the flipped classroom was regularly brought up. Teachers gain more time in class by having the lecture component completed at home. However, video creation and editing are an additional tax on the teacher’s time outside of class. The first year requires the greatest additional time outside of normal classroom planning, as the teacher must create the videos used for class.

Bandura (1997) categorized physiological factors as being a contributor to self-efficacy. This factor was included in the original design and analysis of this research, but we found it difficult to assess the physiological factors within the scope of the study and data collected. This being said, time seemed to play a significant role and the additional time requirement is a stressor on flipped classroom teachers, especially in their first year(s) of teaching in a flipped classroom format.

“There is additional outside of class time involved . . . a lot of time recording videos.” The first year “is a huge, huge tax on your time.” Much of this time is used plan-
ning and finding “time to actually make the videos.” One teacher was “recording the entire pre-calculus course” they had never taught and it’s “time consuming.” Another teacher reflecting on their first year said that “just making the videos were time consuming” and they had difficulty finding time for all of the requirements needed for a successful classroom flip. They went on to say, “there were days when I was getting up at 4am to make the video” for the day. Being the first year, they “didn’t have a library of videos to go to” in order to spend more time improving instruction. When it came to discussing the creation of the videos, another teacher stated, “the time to record the videos is significant and additional.” Teachers reported saving “class time, but you’re losing planning time.” This presented a “major drawback, especially for new teachers,” who may need that planning time. “It just takes so much time to get your video library established.”

Although these issues appeared to be largely overcome by the teachers in this study, they may represent an aspect of teacher efficacy not present in other areas. The flipped model is a departure from traditional teaching methods, as it generally required the creation of digital media that students consume at home. This quasi-unique feature may have implications not addressed in the more customary teacher efficacy model. Future studies should focus on the impact of the additional time that teachers must devote to digital media creation and if teachers’ technological literacy and/or ability are a factor in a flipped classroom setting. Ideally, this study should be longitudinal in nature to help determine if this time commitment lessen in subsequent years after teachers have taught the course in subsequent years.

**Recommendations for Future Study**

This study was limited in that it was conducted using only three teachers who were volunteers from one purposefully selected high school. The school in this study also places a high value on flipping the classroom and necessary resources for teachers and students are provided. We did not quantify teacher efficacy levels and served only to identify the factors within successfully flipped classrooms affecting teacher efficacy. Further research in schools without such a focus may give greater insight into how much school culture impacts successful implementation. Triangulation of qualitative and quantitative data may also lead to greater insight into the effect of the flipped classroom instructional model on teacher efficacy.

Student perceptions were not considered except where teacher perceptions of student engagement and participation were concerned. Studies of K-12 student perceptions on flipped classrooms represent a dearth in the current body of scholarly literature. Future studies should also look to investigate the impact of time exclusively as a mediator of teacher efficacy. Variations in instructional practices between different subjects and school environments may also play a role in the effect of the flipped classroom instructional model on teacher efficacy and ultimately, its use. Studies examining these different environments and subjects would help stakeholders gain a broader picture of the flipped classroom and the most appropriate ways to incorporate the model into instruction.

**References**


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**Cameron Denson** is an assistant professor of Technology, Engineering and Design Education at North Carolina State University in Raleigh, N.C. Cameron’s research efforts are focused on the integration of engineering design into high school curriculums and how this would create pathways to technical careers for underrepresented populations. His research has centered on the influence of co-curricular activities on underrepresented students’ self-efficacy, interests and perceptions of engineering.