Research-based Online Resources to Flip the Chemistry Classroom

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Abstract

The digitally enabled "Flipped Classroom" model is becoming a transformative educational tool for teachers. The scope of this article includes the pedagogy of a flipped classroom for both chemistry teachers and their students. Furthermore, problems commonly associated with classroom flipping will be addressed via research to reconcile any concerns which can intimidate and discourage some chemistry teachers from making a transition to the out-of-class flipped learning approach. Finally, a collection of valuable online resources is included with descriptive links to capture the defining spirit of the flipped learning teaching method using online resources.

Introduction

The digitally enabled "Flipped Classroom" model is becoming a transformative educational tool for teachers [1]. Given this enlightened trend, it seems appropriate to apply the method to classrooms focusing on or incorporating science topics, such as chemistry, which are foundational and affect the future careers, interactions, and lifestyles of students in the US and around the world. Flipping a classroom will enrich the content of science classes in a novel fashion, while still adhering to the Common Core standards, such that the topics will be relevant and interesting to students.

The scope of this article includes the pedagogy of a flipped classroom for both chemistry teachers and their students. Furthermore, problems commonly associated with classroom flipping will be addressed via research to reconcile any concerns which can intimidate and discourage some chemistry teachers from making a transition to the out-of-class flipped learning approach [1, 2]. Finally, a collection of valuable online resources is included with descriptive links to capture the defining spirit of the flipped learning teaching method using online resources.

Overview of Flipped Learning

Flipped learning was formerly defined by screen casts developed by the teacher to provide information through a video medium, allowing digital access and self-driven learning through the student's home digital devices and at a student's own pace versus a traditional classroom [3]. Flipping works to engage students with the lesson content and ensure learners are prepared for face-to-face teacher and/or peer interaction with the newly-acquired content knowledge once they return to the classroom [4].

Flipped Learning with Teacher-made Screencast

1	(Teacher) Develop Content Based Screencasts
2	(Teacher) Screencast is Made Available to Students
3	(Student) Screencasts Reviewed and Revisited as Needed on Personal and/or Mobile Devices Prior to Attending Class
4	(Student) Use of Acquired Knowledge During Face-to-Face Instruction for Analysis and Application
5	(Teacher) Flipped Learning Results Assessed
6	(Teacher) Face-to-Face Instruction Through Collaborative Learning in Whole Group, Small Group and Individual Environments

Several Examples and Models of Flipped Learning in Action

What a Flipped Classroom Looks Like
The Flipped Class: What A Good One Looks Like
The Flipped Class: What It Is and What It Is Not
Teachers "Doing the Flip" to Help Students Become Learners
The Flipped Classroom Guide for Teachers
Flipped Learning Community
The Flipped Classroom Model: A full Picture

Problems Teachers Have Initiating Flipped Learning

While some teachers may be able to manage flipped learning relatively seamlessly and efficiently, the process can be arduous: technology and time are finite resources which formerly required justification to invest towards new pedagogies such as the premise of making and editing screen casts—no small task to those familiar with digital media [3]. As such, we have compiled a list of barriers which previously concerned chemistry teachers who otherwise may have been interested in flipped teaching, barriers which are now easily overcome as will be seen in this article:

- Flipping a classroom is a fundamental change to instructional practices, which will necessarily require time to develop and likely include unique challenges.
- Teachers face an inevitable learning curve as they transition to an unprecedented instruction method on digital platforms, requiring significant professional development.
- Some teachers may be uncomfortable with online recordings of their lessons being available and shared online, particularly, but not limited to, their image and voice.

- Teachers may fear mistakes, redundancy, and similar such issues with their lessons as elements of feelings of inadequacy and lack of qualification for recorded lessons, particularly as platforms used increase.
- Flipped classrooms alter philosophical perspectives on teaching as teachers now facilitate information to a wider, indirect audience.
- As technology evolves, any skills acquired will eventually become outdated, requiring further research to develop themselves and their lessons.

Since the above-mentioned problems deterred teachers in the past from flipping their classroom, it is appropriate to present solutions to resolve these problems and further provide reasons to invest in flipped classrooms as a viable teaching style. Furthermore, applications of the data within the scope of this paper will provide teachers with information to employ outsourced screen casts through rapidly growing online libraries of resources. Therefore, screen casts need not be developed for each individual lesson since one of the key factors of modern-day flipping is quick access to excellent online resources [5].

Advantages of Flipped Learning with Pre-made Online Chemistry Content

Teachers interested in using flipped learning, be it fully or as a supplement, can use a plethora of web-based resources congruent with modern standards. As the Internet becomes an increasingly dense collection of knowledge, resources of high quality and user-friendly implementation are readily available. Such potential media include, but are not limited to video, info graphic, text, and interactive lesson materials, all of which can be quickly viewed by students. Beyond their speed efficiency, there is also an accessibility component since smart phones and tablets are capable of access as well.

Returning to the specific context of teaching the content of chemistry, lessons of depth and rich design can be found already prepared via the Internet rather than needing to be prepared by a teacher him/herself. As the Internet evolves, so too does the information and communications found on it. As a subset of technology, Moore's law may be a good rule of thumb, if only a conceptual approximation of the advancements of the media found online. Given this, teachers would do well to heed the rapidly changing times and apply these resources among their practices, especially when flipping their chemistry lessons for students. The breadth of scope of the Internet can inform both the teacher and the students through well-presented content, aiding all in achieving the ultimate educational goal of learning chemistry well.

Resulting Benefits of Flipped Learning with Online Content

Alongside the planned goals of flipped learning, are ancillary successes as well [6]. For example, the use of digital media places greater accountability on the students in lesson completion, encouraging application and completion of activities found in the classroom [7]. The advantages of well-developed, well-resourced flipped learning lessons include improved content mastery [8]. The wide variety of media, e.g., video and audio, and the equally wide variety of assessment, e.g., web assessments, student-designed media, etc., also allows for an unprecedented level of differentiated instruction. Of course, these are just the tip of the iceberg in terms of flipped learning advantages, and more nuanced advantages also await in the flipped classroom teaching style:

- The teacher can add 5 to 15 minutes per day of instructional time by having students interact with highly motivating videos and other online teaching and learning materials before class as "homework".
- Teachers can increase student motivation and independent learning through providing high quality, engaging and well-researched videos.
- Teachers can then maximize in-class time to help reinforce key concepts and enrich learning through structured group work and other activities back in class.
- Students have "wall's down" 24/7 access to online learning material, assignments, and assessments.

- Teachers can use pre-developed instructional resources, which saves preparation time that can be devoted to assessment and instruction.
- Each student can access online materials conveniently through any handheld device, tablet, or computer.
- Online video instruction provides students the opportunity to revisit and review materials until they achieve the desired level of subject matter understanding.
- The teacher can quickly assess students' knowledge, then to provide additional small group and individualized help in class.
- Teachers can employ digitally enhanced flipped lessons to differentiate instruction for students who speak different languages by incorporating online translators, visuals, virtual manipulatives simulating a Chemistry lab, and audio components.
- Teachers using flipped learning can take advantage of easily accessible text-to-speech software to help students with literacy deficits and with speakers of other languages who struggle to read on grade level.
- Teachers can use online lessons, which can often be assigned in the student's first language and be especially helpful to learners who speak other languages. Online translation services for most written content, like Google Translate, is also available.
- Flipped learning can further individualize and enhance learning by showing students how to find top-quality content related to the chemistry concepts under study. Students can share their specialized learning by generating their own flipped learning presentation for in class and out-of-class assignment.

The vast amount of renowned content creators can allow teachers to inform their own pedagogy through viewership of experts observed in video and other instructional media, extending their teaching to a more energetic state of knowledge and prowess. Perhaps even these inspiring media sources can reignite a teacher's passion for their content area further than the teacher's base passion for chemistry and the physical sciences. Additionally, passionate teachers beget passionate students, engaged in content and molded into practitioners of the subject matter [9]. Online media truly creates a new foundation for fostering lifelong learners for both chemistry teachers and chemistry students.

Quality Online Chemistry Content for Flipped Learning

Following is a collection of highly beneficial links that have been compiled as online resources available to chemistry teachers, which can provide a more seamless transition into flipped learning for interested teachers. At the time of publication, the links were fully operational, though diligence is required for those reading at later dates due to the finite nature of certain online media. These resources can be utilized by instructors or students for chemistry content learning and beyond. The standards by which the authors based these resources are in reference to the International Association of K-12 Online Learning (INACOL) standards and as such create a useful starting pool of high quality online resources and for teachers of 21st century chemistry students.

Online Chemistry Resources

Flipped Chemistry Resources from the Flipped Crowd Sourced Chemistry Community
http://www.flippedchemistry.com/

High School Chemistry Resources & Annotations

Flipped Chemistry Classroom Resources from a Master Teacher in New York
http://www.mrpalermo.com/

Flipped Chemistry Classes Website and Resources for AP Chemistry, Honors Chemistry, Regents Chemistry, and General Chemistry
http://www.chemisme.com/

The "Flipped" Chemistry Classroom Project and Resources at Rancho Alamitos High School
http://morrisonrahs.weebly.com/flipped-classroom-model.html

The Khan Academy: High School Chemistry Resources
www.khanacademy.org

Chemistry Resources

- Atoms, compounds, and ions
- Chemical reactions and stoichiometry
- Electronic structure of atoms
- Periodic table
- Chemical bonds
- Gases and kinetic molecular theory
- States of matter and intermolecular forces
- Chemical equilibrium
- Acids and bases
- Buffers, titrations, and solubility equilibria
- Thermodynamics
- Redox reactions and electrochemistry
- Kinetics
- Nuclear chemistry
- Meet the chemistry professional
- Alkanes, cycloalkanes, and functional groups

Organic Chemistry Resources

- Structure and bonding
- Resonance and acid-base chemistry
- Alkanes, cycloalkanes, and functional groups
- Stereochemistry
- Substitution and elimination reactions
- Alkenes and alkynes
- Alcohols, ethers, epoxides, sulfides
- Conjugated systems and pericyclic reactions
- Aromatic compounds
- Aldehydes and ketones
- Carboxylic acids and derivatives

Alpha carbon chemistry
Amines
Spectroscopy

50 Awesome Chemistry Videos for The Busy Science Teacher from Teachthought
http://www.teachthought.com/uncategorized/50-awesome-chemistry-videos-for-blended-or-flipped-classrooms/

Resources for the Flipped Chemistry Classroom from Allen High School
http://www.allenisd.org/Page/17345

Resources for the Flipped Chemistry Classroom
http://www.sudburyflipped.com/chemistry-flipped-home.html

High School Chemistry Education Resources from ACS Chemistry for Life (American Chemical Society) Resources
https://www.acs.org/content/acs/en/education/resources.html

AACT (American Association of Chemistry Teachers) Classroom Resources
https://www.teachchemistry.org/content/aact/en.html

Resources for Teaching Chemistry
https://www.csun.edu/science/chemistry/

Chemistry Resources from the Royal Society of Chemistry: LearnChemistry:Enhancing Learning and Teaching
http://rsc.org/Learn-Chemistry#!

College Chemistry Resources

The Chemistry Flipped Classroom Experience at the University of South Maine
https://usm.maine.edu/ctel/we're-flipping-crazy-chemistry-flipped-classroom-experience

Flipping Chemistry Classrooms to Refocus College Chemistry Classes
https://www.techsmith.com/flipped-classroom-aaron-sams.html

Flipped Duke Chemistry classrooms at Duke with Clickers Assessment
https://cit.duke.edu/blog/2015/08/flipped-classrooms-chem-201/.

The Flipped Classroomat Ohio State
http://drfus.com/sample-page

Conclusion

Flipped learning currently encapsulates an incomprehensibly large amount of resources and methods for teachers over the seemingly endless Internet, and yet, its capabilities are still growing as online media continues to evolve over time. However, as technology grows, a barrier between the technologically savvy and the less technologically inclined grows. Some teachers may currently be equipped to manage screen casting, but most teachers will eventually need to update their skills as time goes on [3]. Thus, teachers need to be mindful of the times in which they teach, especially while preparing students for a 21st century world.

Teachers who are up to the challenge, however, need not fear the barriers currently presented. One possible means of transitioning, both from a teacher's perspective and the students' is the utilization of chemistry video media in a classroom directly that will allow concerns regarding the independent use of flipped learning instruction, such as being accountable for watching and being assessed on the content of chemistry related videos, to be addressed quickly during this "test drive." Following, online assignments are slowly transitioned in, replacing classroom based ones. Eventually full, or nearly full, transitions can be anticipated. This transition can allow students to maintain the feel of a traditional classroom while advancing their skills in modern technological society. With processes like this to help usher in a new age of instruction, students can benefit through online instructional aides found in this article and those discovered by teachers beyond it.

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