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Self-Flipped Teaching & Learning for STEM in Higher Education

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Abstract. The cultures of social media and *prosumerism* enter the domain of education and power a shift towards learner-centred active learning. This motivates research to develop and evaluate a new instructional and learning strategy that is built on the reuse of student-generated content. The present study proposes an approach, called *Self-Flipped teaching & learning,* where students work in a computer-supported collaborative environment and produce content as part of their own learning (the *self* part of the name). Instructors can use the produced content in their teaching materials for other students in the flipped classroom pedagogical model (the *flip* part of the name). The focus of the study is on science, technology, engineering and mathematics (STEM) subjects and higher education, and the aim is to test the feasibility of the proposed approach by looking at (i) requirements for the students to be able to create quality content as part of their learning, and (ii) issues of reusing this content for teaching other students.

Background and Rationale

Following the rapid adoption of Massive Open Online Courses by world-leading universities, a form of blended learning called flipped classroom is increasingly being applied in the context of higher education worldwide (Bishop & Verleger 2013). In flipped classroom course material is delivered to students in the form of multimedia materials via digital media, so students prepare for class in advance by studying the material outside of class time at their own pace. The class time is then dedicated for developing the knowledge further by solving various problems together with the teacher and other students (Bishop & Verleger 2013). This approach advocates the principle of student-centred active learning that ensures

"greater student involvement and knowledge retention" (Bonwell & Eison 1991). Many instructors recognise these advantages of the model for STEM subjects and gradually introduce the approach to their curriculum (Bishop & Verleger 2013).

However, flipped classroom is criticised for adding a substantial workload to the instructors (Moffett & Mill 2014). The creation of high quality and engaging pre-class materials demands great time investment. Furthermore, instructors who are new to the concept and have no prior knowledge in multimedia content creation are likely to require additional training and support. We propose *student content creation* as a solution for those instructors who wish to use the flipped classroom approach but are hindered by the above issues.

The development of Web 2.0 technologies, which emphasise user-generated content along with user interaction and collaboration (Mcloughlin & Lee 2008), power the growing trend: yesterday's *audience* increasingly become content *creators* and *communicators* (Wheeler et al. 2008). Digital technologies have also become much more accessible, offering opportunities for students to learn through making their own digital artefacts. There is growing evidence of learning improvements for students who engage in content creation. Examples of student-generated content effectively introduced into the curriculum include: multiple-choice questions (Hardy et al. 2014), editable wikis (Wheeler et al. 2008), narrated animations (Hoban et al. 2010), and tutorials (Hamer et al. 2008).

Further to linking the creation of digital products with deeper subject learning and improved academic performance, evidence suggests additional benefits, such as promoting the development of multiple "soft skills" (Hamer et al. 2008), as well as accumulating tangible objects for student learning portfolios (Mcloughlin & Lee 2008). Finally, when tasked with creating digital products for the purpose of teaching, students are also encouraged to reflect on how best to communicate their learning to others, which further embeds their own learning (Dale 1946).

While there are many studies that advocate, separately, for flipped classrooms and student content creation, we have not found solid examples of combining these approaches together. This research is set to investigate how the best aspects of flipped classroom and student content creation could complement each other and form the basis for the proposed *Self-Flip approach*. Student content creation could provide flipped classroom instructors some help with multimedia materials generation; while the model of flipped classroom in its turn could facilitate the student content creation by allowing more time in the classroom for practical sessions and peer-learning in the presence and with the guidance of the instructor.

Methodology

The Self-Flip approach is grounded on two mutually complementing theories: the cognitive theory of *constructivism* and the learning theory of *constructionism*. The *constructivism* theory argues that knowledge is actively constructed by a learner through the contact with the world (Piaget & Elkind 1968). It mostly

focuses on individual knowledge construction, where meaning is discovered and formed into unique structures that continuously evolve through the interaction with other people and things (Ackermann 2001). This theory fits the part of Self-Flip focused on in-class active learning activities. The *constructionism* theory covers the 'making' part of Self-Flip: it focuses on helping the students produce constructions that others can see and critique; it explores how learners engage in a conversation with their own or other people's physical constructions or artefacts, and how these conversations encourage self-directed learning, and as the result enable the construction of new knowledge (Ackermann 2001).

The main research question of this study is:

Is Self-Flipped teaching and learning feasible in STEM higher education?

To answer this question, the following set of sub-questions has been developed:
1) What skills and literacies students from technical programmes require in order to produce meaningful digital artefacts as part of their learning outcomes?
2) To what extent do students feel that their learning experience improves through the production of such learning outcomes?
3) Is quality of the produced artefacts sufficient to reuse them for teaching?
a. Instructor perspective – good enough for teachers to use?
b. Student perspective – good enough for future students to trust?

The mixed-method approach with the case-study design was chosen as the most appropriate for this research. The case-study comprises three cases within three schools from the Faculty of Science, Agriculture & Engineering at Newcastle University, UK, and one case from the Department of Information Technology at Uppsala University, Sweden. Each of the case studies will go through the full process of Self-Flip cycle (phase one: *production*; phase two: *reuse* of the student-generated content) at least once during the course of this research. The modules for the cases were chosen in order to represent different teaching formats and different levels of students, as well as to accommodate various types and methods of student content creation.

During the first two years of the study a large amount of qualitative data was collected: classroom observations for 5 full semester-long courses, 29 student and 10 instructor interviews, and analysis of 338 artefacts. Later on, more quantitative techniques, such as questionnaires and statistic data analysis are planned to be used to get greater response rates and to triangulate the qualitative findings.

Findings to Date and Next Steps

So far, the first phase, *the production*, of the Self-Flip has been tested 4 times, once per each of the case studies. The findings to date allow us to partially answer the first research sub-questions about skills and literacies that students require for digital artefact creation. Thus, for example, analysing collaborative creation of video tutorials for a computing science course we investigated how students

demonstrate development of media literacy skills (Vasilchenko et al. 2017). These skills are essential for student ability to create quality multimedia messages which both embed their own learning and serve as a meaningful message for others.

Another significant finding that came out of the collected data is ethical norms for collaborative content creation and remixing, in particular. When allowed to use pre-production materials created by other students some failed to demonstrate an adequate comprehension of fair use and attribution concepts. At the moment, we investigate this issue in greater detail.

Overall, from the testing of *the production phase* we can conclude that students are capable and generally ready to *produce* artefacts which will be suitable for further use. Furthermore, anecdotal evidence suggests that students feel that their learning experience improves as they enjoy the innovative teaching approach and get more engaged with their learning.

The next step will be to test *the reuse phase* of the approach. At the moment we are working with the module instructors from the case studies to select artefacts from the first phase and to incorporate them into the teaching materials for the next iterations of the modules. With the data from the second phase we plan to investigate such issues as quality, trust and sustainability of the Self-Flip. Ultimately, by answering our research questions we aim to design a new pedagogical model which will ease the transition from traditional to flipped classroom teaching for the instructors, and at the same time enhance student learning experience through the production of digital learning materials.

References

Ackermann, E. (2001): 'Piaget's Constructivism, Papert's Constructionism: What's the difference', *Future of learning group publication*, vol. 5, no. 3, 2001, pp. 438-449.

Bishop, J.L. and Verleger, M.A. (2013): 'The Flipped Classroom: A Survey of the Research', *ASEE National Conference Proceedings, Atlanta, GA,* vol. 30, no. 9, June 2013, pp. 1-18.

Bonwell, C.C. & Eison, J.A. (1991): *Active Learning: Creating Excitement in the Classroom,* Washington, D.C.: The George Washington University.

Dale, E. (1946): *Audio-Visual Methods in Teaching,* 1st ed., NY: Dryden Press.

Hamer, J. et al. (2008): 'Contributing Student Pedagogy'*ACM SIGCSE Bulletin,* 2008, pp.194-212

Hardy, J. et al. (2014): 'Student-Generated Content: Enhancing learning through sharing multiple-choice questions', *International Journal of Science Education*, vol. 36, no. 13, pp. 2180–2194.

Hoban, G., Nielsen, W. and Carceller, C. (2010): 'Articulating constructionism: Learning science though designing and making "slowmations"', *ASCILITE* 2010, pp. 433–443.

Mcloughlin, C. and Lee, M.J.W. (2008): 'The Three P's of Pedagogy for the Networked Society', *International Journal of Teaching & Learning in Higher Education*, vol. 20, no. 1, pp. 10–27.

Moffett, J. and Mill, A.C. (2014): 'Evaluation of the flipped classroom approach in a veterinary professional skills course', *Advances in Medical Education & Practice*, vol. 5, pp. 415–425.

Piaget, J. & Elkind, D. (1968): *Six Psychological Studies*, Vintage Books.

Vasilchenko, A. et al. (2017): 'Media Literacy as a By-Product of Collaborative Video Production by CS Students', *Proceedings of the 2017 ACM Conference on Innovation and Technology in Computer Science Education*, June 2017, pp. 58-63.

Wheeler, S., Yeomans, P. and Wheeler, D. (2008): 'The good, the bad and the wiki: Evaluating student-generated content for collaborative learning', *British Journal of Educational Technology*, vol. 39, no. 6, pp. 987–995.