Commonwealth of Learning

Report of the Massive Open Online Course on

Teaching Chemistry with Technology

First offering: 8 January – 23 February 2023

The Commonwealth of Learning (COL) is an intergovernmental organisation created by Commonwealth Heads of Government to promote the development and sharing of open learning and distance education knowledge, resources, and technologies.

Acknowledgements:
This report has been prepared by Dr. Nathaniel Ostashewsky, Lead Instructor for the massive open online course on TCT under the guidance of Dr. Evode Mukama, Adviser: Teacher, Commonwealth of Learning.

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Executive Summary

Teaching Chemistry with Technology (TCT) is a massive open online course (MOOC) developed by the Commonwealth of Learning (COL) and a team of consultants including Dr. Nathaniel Ostashewski and Mr. Dan Wilton. This report summarizes its delivery and outcomes from its first offering of the TCTMOOC held 8 January – 12 February 2023.

The purpose of TCT MOOC is to introduce virtual simulations and specifically the PhET open access simulations that have been developed for educators to support their chemistry education teaching and learning practices. Participants explored simulation examples and how they can be used in chemistry teaching to incorporate active learning. PhET simulations developed and shared openly by the University of Colorado in the USA (https://phet.colorado.edu/) were the primary focus of the course. Other chemistry resources and simulations (online or offline) that can be used to engage their learners in chemistry education were a secondary focus of the course. The participants had the opportunity to meet and discuss challenges presented in chemistry education throughout the duration of the MOOC that included chemistry and pedagogy experts who guided participants through course resources and activities.

There were 1302 student registrants in the first offering of TCT MOOC, of which 769 logged into the mooKIT learning management system at least once. Participants who completed the minimum requirements based on quiz completion and scores were awarded Certificates of Participation. Participants who went on to develop an original TCT Lesson Plan or TCT Worksheet were awarded the higher value Certificate of Completion. In total there were 296 TCT MOOC Certificates awarded for a total certification rate of 38.5% based on the 769 students who logged into the course, or 22.7% based on the 1302 student registrations. Of the 296 certificate recipients, 139 (47.0%) were awarded the Certificate of Participation and 157 (53.0%) were awarded the more challenging Certificate of Completion based on successful completion and submission of an original Chemistry Lesson Plan or Worksheets.

Based on the End-of-Course survey responses and comments in the course forums and live chat tools and the overall high level of engagement by the participants, this first offering of TCT MOOC was well-received and effective. Survey responses indicated the majority of participants were very satisfied and would recommend the course to others. Despite the Community of Inquiry being a new online delivery approach for many learners, their willingness to be a community member in this MOOC – sharing resources, providing examples, and engaging in many discussions – demonstrates that they not only learning about chemistry teaching, but also online teaching. Adjustments to the find assessment and number of live sessions are recommended for future offerings. The following comment from a participant provides an excellent summary for the course:

> *Keep it up! It is really helpful to the chemistry teachers' community worldwide, even if many of us maybe we don't communicate enough on the forum; it is because of very demanding work we have as teachers (particularly on my side) but I have to manage and follow, try to learn more because I found this course very interesting as it will help me in my chemistry teaching. I do appreciate your work. Thank you very much, be blessed! Let's continue work together and learn from each other. Thank you.*

This report on the first offering of TCT MOOC is prepared by Dr. Nathaniel Ostashewski University for the Commonwealth of Learning.

Section 1. Background of TCT MOOC

Science, technology, engineering and mathematics (STEM) education, as envisioned by the UN in 2022, seeks to tackle real-life challenges using an integrative approach with technology. These challenges encompass various sectors, such as energy, health, food production, infrastructure, manufacturing, and the environment. However, STEM education faces obstacles in developing countries, including funding shortages, inadequate infrastructure, deficient curricula, a gender gap, and institutional capacity limitations. For example, less than 25% of Africa's higher education students pursue STEM fields, in contrast to developed countries like the United States, where STEM graduates have shown significant growth[1]. To improve STEM education in Commonwealth and beyond as part of its strategic plan 2021-2027, the Commonwealth of Learning (COL) introduced the TCT MOOC, leveraging Open Educational Resources (OER) and Open and Distance Learning (ODL) to empower teacher education and training. The initiative fosters a community of learners sharing resources and ideas related not only to chemistry but also online teaching and open educational resources. PhET simulations used in this MOOC will help in connecting abstract concepts to chemistry processes. Ultimately, these efforts aim to bridge the gap and enhance STEM education in regions facing challenges to provide equal opportunities for students to thrive in the modern world. The TCTMOOC offers an exemplary online professional development model aimed at eliminating barriers to education and fostering globally accessible high-quality lifelong learning opportunities.

Need and purpose

While the global pandemic of 2020-2022 moved education practice to emergency remote teaching and online delivery, teachers around the world are challenged in finding meaningful and impactful ways to use digital technology in science education. Post-pandemic, the identification and sharing of open digital resources that support chemistry education is one way in which to build teacher capacity with technology tools and the strategies that make use of them for teaching. This project worked to address these two identified needs for chemistry educators using a networked teacher professional development approach[2] using an Inquiry-based MOOC design[3].

The purpose of TCT MOOC is to provide participants with an opportunity to expand their knowledge of OER technology tools that can support chemistry education. In the course participants explored background educational practice knowledge about online and blended education, chemistry teaching philosophies, Open Education Resources, the scientific method, and how to utilize digital simulations (online or offline) to engage learners in their chemistry teaching. Examples of how to incorporate active learning and simulations that can engage their learners in chemistry education are a key part of the course as is the participant discussions around using digital tools and resources in teaching practice. The participants have many

[1] UN. (2022). Science, technology, engineering and mathematics (STEM) as an enabler for development and peace. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.un.org/osaa/sites/www.un.org.osaa/files/docs/2116613_stem_policy_paper_web_rev.pdf.

[2] Ostashewski, N. (2013). Networked teacher professional development: Assessing K-12 teacher professional development within a social networking framework [Unpublished doctoral dissertation]. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://dt.athabascau.ca/jspui/bitstream/10791/26/5/NathanielOstashewskiFinal.pdf.

[3] Cleveland-Innes, M., Ostashewski, N., & Wilton, D. (2017) iMOOCs and learning to learn online. Community of Inquiry Blog Post. Retrieved from: http://www.thecommunityofinquiry.org/project5.

opportunities to meet and discuss challenges presented in chemistry education which chemistry and pedagogy experts guide them through the use of PhET simulations.

Team members

From the Commonwealth of Learning:

Dr. Evode Mukama, Advisor – Teacher Education

Karmila Harder, Course Administrator

Consultants for the Commonwealth of Learning:

Dr. Nathaniel Ostashewski, Course Instructor

Daniel Wilton, Course Technical Administrator

Jenine Hawryluk, Course Facilitator

Prisca Byukusenge, Course Facilitator

Design and development

The TCTMOOC was developed though a consultation agreement with Dr. Nathaniel Ostashewski who has extensive online instructional design and teaching experience as well as over 15 years of K12 classroom science teaching. The MOOC design structure and process is based on a scaled version of the Community of Inquiry theoretical framework and is referred to as an Inquiry-MOOC design. More information about this instructional design and how it is structured as well as implemented is available from an open access book written on the subject by Dr. Ostashewski and his colleague Dr. Cleveland-Innes.

Technology

The TCT MOOC is offered by the COL through the mooKIT platform, an open-source learning management system for small- to medium-sized MOOCs. According the mooKIT (https://www.mookit.in/):

> "mooKIT is a MOOC Management software designed and developed at IIT Kanpur. mooKIT is a system that instructors, learners, and system administrators find easy to work with - designed for "Internet Novices." Its unique architecture makes it highly customizable and cost-effective at any scale."

Key design features of this MOOC platform are:

Adaptable to Varying Bandwidth	Bandwidth Indicator to choose the delivery mode from video (when high), audio (when modest) or via phone.
Discussions	Forums for in-depth discussion, Hangouts for quick and real-time interactions.
Internationalization	Select preferred language for the navigation menu. Integrate new languages easily.
Assessments	Quizzes and Assignments for evaluation.

Certification	Generate certificates from template.
Analytics	Monitor and gain interesting insights as the course progresses.
Customizable	Adapt to local needs.
Cost-Effective	Handles high traffic on low-end servers. Huge savings in hosting costs.
Progressive Apps	Videos can be downloaded, and content can be cached locally. Both iOS and Android Apps available.
Digital Certificates	Cryptographically signed digital certificates can be issued on public blockchains like Bitcoin and can be accessed using a wallet. They are tamper-proof and independently verifiable.

With regards to the TCTMOOC, key design features of this MOOC platform are:

- synchronous and asynchronous interaction through forums and live chat capability,
- a management interface that allows for course content to be developed without its being published,
- ability to understand learner participation in the course through analytics that include page views, forum participation, video content tracking, social network analysis of discussion forums, registration data over time, engagement data over time, and evaluation (assessment tracking)

Marketing

Target learners for TCTMOOC are teachers in developing countries. COL carried out marketing efforts as the organization has an established network of connections in the education sector throughout the developing world. The TCTMOOC website is promoted through COL's network and the promotional brochure is distributed through COL's Focal Points in the Commonwealth countries. Content of the information and registration website is shown in Appendix A of this report. The marketing brochure is shown in Appendix D of this report.

Section 2. Delivery of the TCT MOOC

There were 1302 registrants for the first offering of TCT MOOC during the official delivery of the course. Of these, 769 (59.6%) logged into the course at least once. It should be noted however that for the purposes of the data presented in this section after the course officially closed, there were 32 additional learners who joined the course – and therefore the course demographics are presented on the full 1334 learners who have been in the TCTMOOC as registrants up until March 26th, 2023.

Demographic data

The following demographic information is based on registrants' responses collected in the registration process

Distribution by country. Registrants attended from 71 countries, with Kenya representing 21.1% of the registrant population, followed by India at 21.8%. Table 1 lists the most frequently indicated countries by survey; the full list of country demographic data is included as Appendix F.

Table 1. Distribution of registrants by country: Top 10 (*n*=1301)

Country	Number	Percent
Kenya	275	21.1%
India	284	21.8%
Nigeria	162	12.6%
Fiji	146	11.2%
Rwanda	109	8.4%
Ghana	33	2.5%
Trinidad and Tobago	29	2.2%
Canada	16	1.2%
Tanzania	16	1.2%
Zambia	15	1.2%
Mauritius	13	1.0%
Swaziland	36	1.0%

Distribution by gender. Over 61% of the registrants (*n*=1334) were male. The distribution by gender is provided in Table 2.

Table 2. Distribution of registrants by gender (*n*=1334)

Gender	Number	Percent
Male	825	61.8%
Female	508	38.2%
Prefer not to disclose	1	0.0%

Distribution by age. The ages of registrants (*n*=1334) were broadly distributed but unlike other MOOCs 41.6%of registrants were 25 years old or younger. The distribution by age is provided in Table 3.

Table 3. Distribution of registrants by age (*n*=1332)

Age	Number	Percentage
16 - 20	170	12.76%
21 -25	384	28.83%
26 - 30	201	15.09%
31 - 35	183	13.74%
36 - 40	148	11.11%
41 - 45	119	8.93%
46 - 50	60	4.50%
50 and older	67	5.03%
Total	1332	100.00%

Distribution by education level. Registrants (*n*=1301) were in general highly educated which is consistent with MOOC literature, however there were a large contingent of participants with undergraduate degrees only (542) that comprised the largest group in the TCTMOOC. Undergraduate participants, with 41.7% are the largest group of participants suggesting these likely represent the K12 teachers. The distribution by education level is provided in Table 4.

Table 4. Distribution of registrants by education level (n=1301)

Education Level	Number	Percent
Not disclosed	8	0.6%
High school diploma	34	2.6%
Others	35	2.7%
Pre-university	99	7.6%
Doctorate	127	9.8%
Post-graduate	456	35.0%
Undergraduate	542	41.7%

Distribution by professional affiliation. Registrants were also asked to identify their professional affiliation and level, with the largest number indicating an affiliation with academia (52%), followed by individuals (33.4), and government institutions (11.5%). The distribution by professional affiliation is provided in Table 5.

Table 5. Distribution of registrants by professional affiliation and level (n=1301)

Professional affiliation	Number	Percent
Academia	677	52.04%
Individual	434	33.36%
Government	149	11.45%
Non-profit organization	34	2.61%
For-profit organization	4	0.31%
No response	3	0.23%

Course resources

The TCT MOOC was developed by Dr. Ostashewski in consultation with Dr. Mukama over a period of four months beginning in September 2023. Important in the design process was a focus on open access resources that could be sourced or produced as content for the TCTMOOC. The University of Colorado, PhET's host organization, provided confirmation that the resources and tools on their portal were open access, therefore became the focus of the tools that the course would be designed around. Videos, online resources, and activities were organized to support the course design with many of the resources being created along the way. The final design resulted in a set of video clips being recorded that represented content and activities over the 5 weeks of the course. A list of the video clips developed for the course is presented in Table 6.

Table 6. Video resources developed for the MOOC

Video	Title
Promo	Teaching Chemistry with Technology
1.1A	How online learning works
1.1B	The Community of Inquiry
1.1C	Participant roles
1.2A	The scientific method
1.2B	Teaching philosophy
1.2C	The TPACK framework
1.3	PhET use in the classroom
2.1A	Active learning and simulations in science education
2.1B	PhET simulations in chemistry education
2.2A	How do teachers use PhET in chemistry?
2.2B	An example of PhET in chemistry
2.3	OERs and Creative Commons licenses
3.1A	What is blended learning?
3.1B	Blended learning for chemistry teaching
3.2	Guidelines for blended learning using PhET
3.3	Planning your own lesson using PhET
4.1	Creating a chemistry simulation lesson plan
4.2	Assessment for chemistry simulations
4.3	Other technology tools for chemistry teaching
5.1	Evaluating chemistry lesson plans
5.2	Reflections on teaching chemistry with TEL

Another aspect of the course resources is their organization for learner access. The mooKIT platform allows the course design team to present weekly resources in an easy access format. Image 1 shows how the platform presents information to learners, where the learner controls access using the Tabs on the left side of the course Home Page. One challenge with the platform is the platform requirement for learners to be organized using video clip content with discussion forums being an automated element of each video. Participants may get confused where to access the weekly Activity Pages – which are the actual instructions that participants need to interact with the weekly resources and the guide for interactions. The Resources Tab lists the weekly Activity pages for easy access while course activities are released on a weekly basis to allow for course pacing.

Where interaction using the discussion forums is a focus for an online course, weekly pacing via staged publishing of course pages is important.

Image 1: TCTMOOC Home Page in mooKIT

Discussion participation

Discussion is an important component of TCT MOOC which is based on interactions with learners and each other being critical to the MOOC's success. Introduced early in the course as critical to building a community of inquiry of online learners, discussion participation in terms of original posts and responses to the posts of others is frequently encouraged by the course instructor and facilitators. Most of the course resource focussed discussions took place within the pre-established module forums that make up a significant part of the weekly activity. One of the unique elements of the inquiry-based MOOC design is the high level of focus on participant discourse. The result of this design is a high level of engagement that continues to happen across

the full timeline of the course. In the TCTMOOC the level of engagement, measured by the mooKIT analytics as forum posts, remained stable of the entire 5 weeks of the course, as shown in Image 2 below.

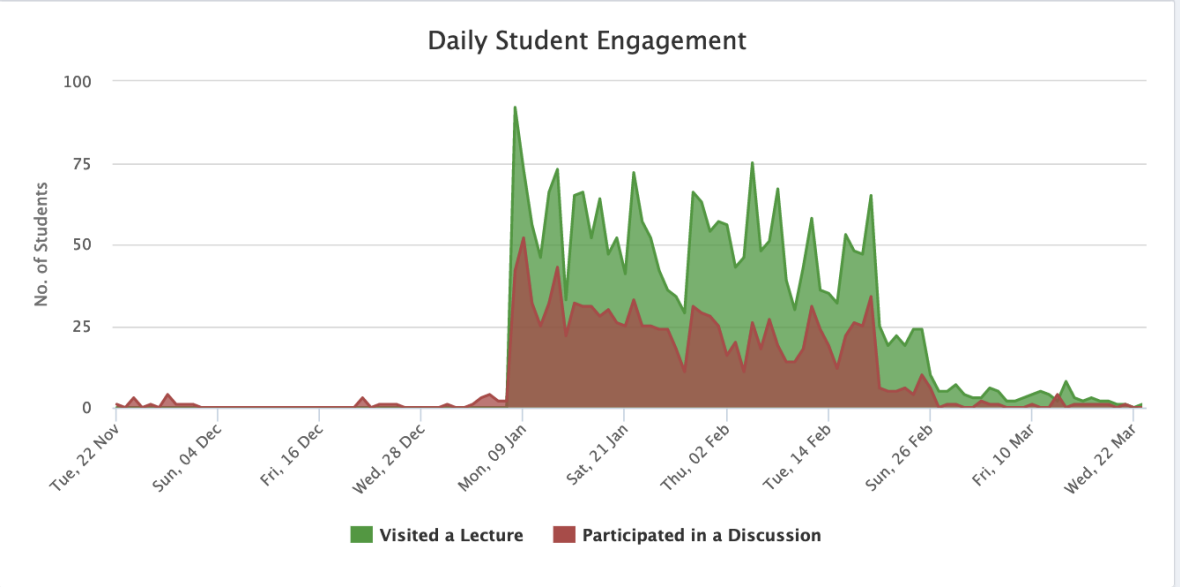


Image 2: TCTMOOC Levels of Engagement over time.

In total, there were 3186 discussion posts across a total of 569 discussion forums, most of which are in participant-generated forums. In total there were 554 participant created forums with 2172 posts made to these forums. Several of these participant-created forums were found directly attached to the weekly content videos that are displayed in the mooKIT platform. Below is an example (Image 3) of how mooKIT presents video content with discussion forums directly below the video. Note that the Activity forum 1.1 has 95 posts, while there are an additional 24 participant created forums (not shown in the image) under this video with posts in those 24 forums ranging from 0 (the forum was created with no further replies posted) to 22 posts.

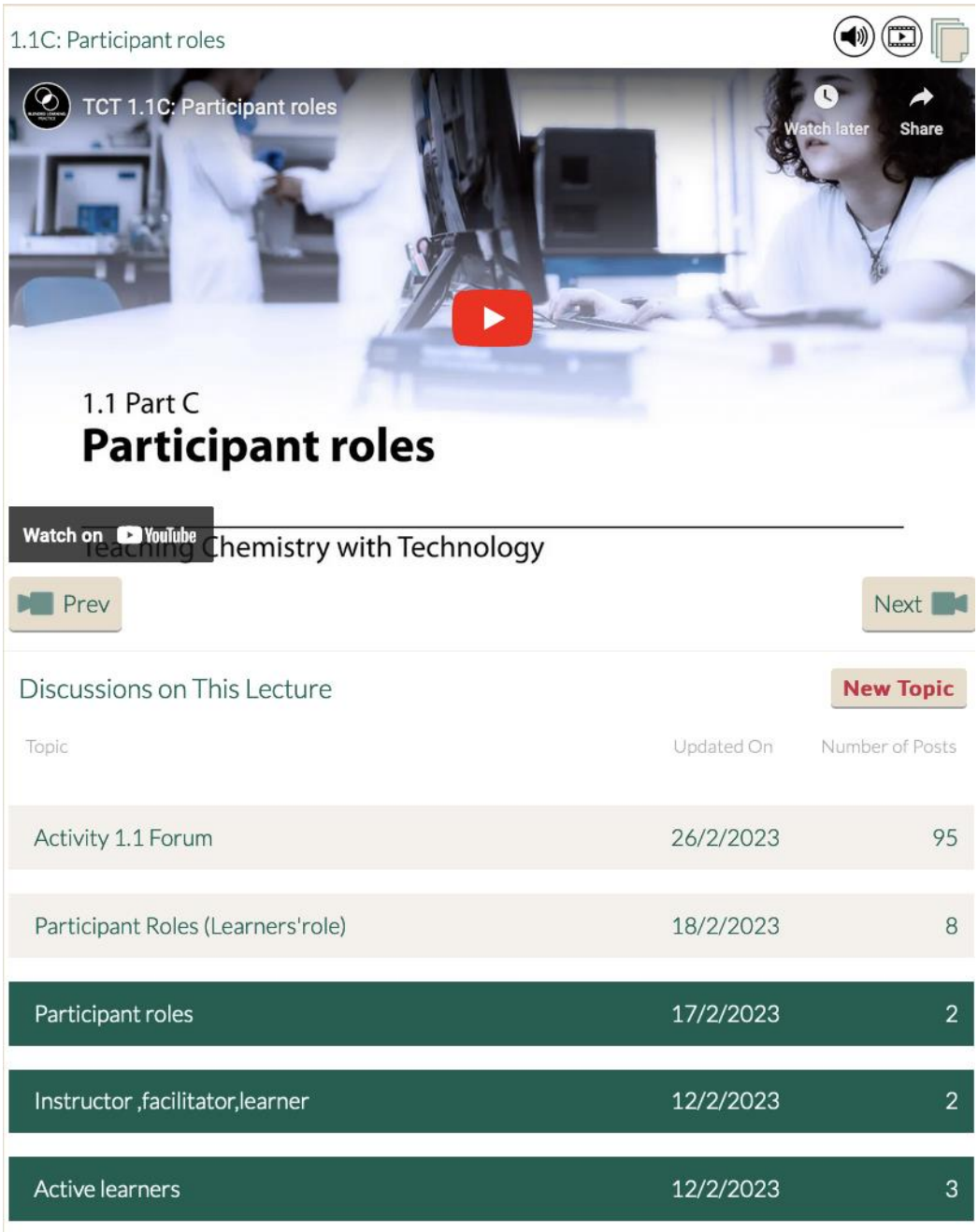


Image 3: TCTMOOC Discussion Forums below Video content.

The distribution of posts by Weekly Activity forum is shown in Table 7. Table 7 shows the forum posts made directly to the Instructor-created forums which participants were directed to in the Activity pages of the course.

Table 7. Discussion posts by forum type

15 Course Activity Forums	Posts	Total
Week 1: Forum 1.1, 1.2, 1.3	95, 97, 95	287
Week 2: Forum 2.1, 2.2, 2.3	80, 67, 65	212
Week 3: Forum 3.1, 3.2, 3.3	73, 72, 69	214
Week 4: Forum 4.1, 4.2, 4.3	46, 31, 52	129
Week 5: Forum 5.1	49	49
Interactive PhET by Prisca Byukusenge	77	77
Using PhET Simulations by Kelly Johnson & Angelo Delli Santi	46	46
Total in all forums		1014

Synchronous sessions

While most of the course is delivered through multimedia web content and asynchronous discussions, one live synchronous session was provided for course participants to join.

> Live Session Wednesday February 1, 2023. at 6:00 pm MST (Mountain Standard Time - Use this link to check the time this session will occur in your location). In this session chemistry teachers Mr. Kelly Johnson & Mr. Angelo Delli Santi will share their PhET experiences both in the classroom and online settings. Join us for a one-hour live session via ZOOM. The Zoom link will be posted 5 hours prior to the live session (see the RESOURCES page for details).

For this online presentation Zoom was used as the session conferencing platform. This web conferencing tool allows for verbal communication, text chat, PowerPoint presentations and screen sharing, all of which added interactivity and active engagement to web-based meetings. As well Zoom allows for recording of the sessions which were then posted into the course space as resources.

In this live session, learners were able to follow along as two experienced chemistry teachers presented how they used PhET and other online chemistry tools in their teaching practice. Mr. Kelly Johnson – a high school classroom teacher, spoke about how he uses PhET simulations in his high school chemistry courses. Mr. Angelo Delli Santi, an online secondary science teacher, shared how he has used PhET simulations as well as other open access resources in his chemistry teaching. The session had 42 participants who attended with several questions being asked in the chat section of Zoom which the presenters responded to. After the session the recording (57:51 minutes) was posted on the course site and participants who could not attend synchronously had an opportunity to view the resource and continue with comments and questions to the presenters. A total of 46 posts were made to the forum attached to the live session recording. Here are a few examples from the discussion forum attached to the live session recording:

I loved the resources shared by Angelo and the ideas shared by Kelly on how we can use the PhEt were very informative. I am happy I attended

Thank you so much for posting this live video, it is really helpful for us to upgrade the level of understanding and teaching chemistry in our schools it won't go in vain and personally I've gotten my portion

Watching this demonstration has inspired me to continually go and check the PhEt sims being added as well as the others already there.

Very interactive. Has given more insight to the use of simulations in teaching abstract concepts in chemistry.

A second live session was planned with one of the course facilitators, Prisca Byukusenge, who was knowledgeable about PhET simulation use in chemistry teaching. However due to intermittent internet access and challenges with stable enough connections, this second live session was modified. Rather than a fully live presentation, Prisca was asked to screen record her presentation, something she had not done previously. Her recording was uploaded to the course website (and YouTube) where it was used as a discussion type interaction directly with her – but the interactions were in a asynchronous format. Below is a segment of the week 5 announcement with instructions for her recorded session and interactions with her:

Recorded video of last weeks live session is available at the very bottom of the Course Home module listings - under the Presentations TAB. You can join in the discussion and access resources from the forum attached to this live session recording.

Secondly we have one of our facilitators - Prisca - who has also recorded a PhET session presentation and you can join her in a discussion (and ask her questions as well) in the forum that can also be found under the Presentations TAB.

This second version of an interactive session – as a recorded video segment of a presenter describing her use of the PhET simulation – was a way that technology issues could be worked around, yet still provide resources for the TCTMOOC participants.

The step-by-step instructions are helpful, thank you. I have used the states of matter and acid-base sims with students, and they really enjoyed themselves.

Very informative and interesting. Week four has been a blast even though it had a lot going on.

Thank you very much Mrs. Prisca!
I really enjoyed the presentation.
When it comes to students' engagement and exploration of scientific concepts, PhET play a great role.
Let's try it!

The simulation help teachers to help abstract knowledge to real life in the classroom.

It also help teachers who cannot access physical materials to present their lessons use PHET sims. Thanks for your wonderful presentation.

Overall, these "practical application of PhET" sessions – one synchronous and the other asynchronous were provided for learners. The recordings allows participants unable to join the sessions live and to support further discussion. Links to these recordings in the course space and also YouTube, along with the session slides, were posted to the course resource page.

Section 3. Participant Performance

Weekly quizzes

Each of the five weeks in the course included a multiple-choice quiz, with the week 5 quiz being one that was based on the entire course. A minimum score of 70% is required on each quiz to qualify for a certificate. Participants were allowed multiple attempts on all quizzes which is an important consideration for achieving a mastery orientation within an open professional development course. The number of participants who attempted each quiz and the average scores are provided in Table 8. While only 282 learners completed week 5 quiz, the quiz average across all 5 quizzes was used in the awarding of certificates.

Table 8. Number of participants who attempted each quiz and average quiz scores

Quiz	Attempts	Mean Score
Quiz Week 1: Technology and education	425	81%
Quiz Week 2: PhET simulations and OER	356	85%
Quiz Week 3: Blended learning and PhET activities	335	85%
Quiz Week 4: Planning for chemistry activities	304	80%
Quiz Week 5: TCT Course review	282	80%

TCT Lesson Plan & TCT Science Activity Worksheet

Creation of a Lesson Plan or an Activity Worksheet is the final assignment and a requirement for the Certificate of Completion. A total of 228 plans or worksheets were submitted, of which 157 (68.9%) were successful. As with the quizzes, participants who did not meet the requirements for the assignment were allowed as many attempts as they wished with the final attempt being the grade that was assigned. The template for the Lesson Plan or an Activity Worksheet is included as Appendix E.

Certificates

Two levels of certification were made available in the TCTMOOC based on learner's level of participation and completion of tasks/activities:

- Certificate of Participation requires 70% or more on each quiz and participation in at least three discussion forums.
- Certificate of Completion requires 70% or more on each quiz, participation in at least three discussion forums, and successful completion of a TEL Chemistry Lesson Plan.

Participants who achieved the minimum requirements based on quiz scores were awarded Certificates of Participation; those who went on to complete the TCT Lesson Plan or Science Activity Worksheet were awarded Certificates of Completion. There were 139 Certificates of Participation awarded and 157 participants were awarded the more challenging Certificate of Completion.

Certificates are made available through a certificate system accessible to participants under their Profile linked to their registration in the course. Under this system, participants can download their PDF certificates on demand which allows participants to download, print, and share their certificates with minimal technical knowledge.

While MOOCs have in the distance education literature been providing a completion metric based on registrations (certificates/registrations) a more appropriate completion rate metric based on the number of learners who can be described as either active or fully active in the course is provided as well in this TCT MOOC report. In the context of MOOCs[4], *active learners* are those who have signed into the course space at least one time. Similarly, *fully active learners* are defined as those learners who log into the course and complete the first week of activities. In the case of the TCT MOOC, fully active learners are those who completed the first week of activities as evidenced by a completed week 1 quiz (425).

Using active learners, those 769 participants who logged in at least one time, a certification rate of 38.5 % was achieved in the course. Using the best measure, fully active students, 69.6% of the 425 fully active learners in the course achieved a Course Certificate. Of these, 53.0% (or 157 of the 296 certificates awarded), were a Certificate of Completion. The certification rates for active and fully active learners are shown in Table 9 and the results shown in this table provide what could be argued is the best representation of the TCT MOOC completion rates.

Table 9. Active and fully active learner certification rates

Category	TCT
Registrations	1302
Active Learner	769
Fully Active Learner	425
Participation Certificates Awarded	139
Completion Certificates Awarded	157
Certification Rates	
Registrations	22.7 %
Active Learner	38.5 %
Fully Active Learner	69.6%

[4] Ostashewski, N., & Cleveland-Innes, M. (2022) *Participant Experience in an Inquiry-Based Massive Open Online Course*. Commonwealth of Learning, p. 56-58. https://doi.org/10.56059/11599/4132

Section 4. Survey Findings

Basic demographics and professional roles of respondents to the registration survey has been discussed in Section 2. Here, additional results from the two course surveys will be presented: the results from those who consented to the Pre-course survey (n=182) and End-of-Course survey (n=130). The two surveys used the same consent letter; see Appendix H. A copy of the Welcome survey and the End-of-Course survey are included as Appendix I and J, respectively.

Summary of Pre-course survey results

Of the 182 responses indicating a primary language, 142(79.8%) reported English as a primary language.

The majority of respondents (75.6%) indicated their teaching experience was 15 years or less. The overall distribution of teaching experience of respondents is provided in Table 9.

Table 9. Teaching experience of Pre-course survey respondents: (n=182)

Teaching Experience	Number	Percent
Education student	30	17.4%
Less than 5 years	28	16.3%
6-15 years	72	41.9%
16-25 years	27	15.7%
More than 25 years	15	8.7%

Question 10 of the survey asked respondents what teaching setting their job involved and respondents were asked to select all the categories that applied to them. Most respondents (76.2%) indicated that they taught in a face-to-face setting, however 38.1% indicated they were online teachers or facilitators and 33.9% reported they were in a hybrid or blended teaching setting.

Questions 11 and 12 asked respondents to describe the level of school they teach (Q11) and what school level their chemistry teaching is at. Approximately 70% of respondents indicate that they teach chemistry at the high school level.

Most respondents (79.5%) self-reported that they were proficient or advanced in acting as a leader in formal or informal situations but felt less confident in using digital tools or supporting new technology and pedagogy for teaching and learning. The self-reported skill levels for these skills are summarized in Table 10.

Table 10. Self-reported skill levels of welcome survey respondents

Skill	None/Basic (%)	Proficient/Advanced (%)
Using standard computer programs (word processor, email, etc.)	2 (1.2%)	137 (79.6%)
Using social media (eg. WhatsApp, Twitter)	5 (2.9%)	126 (73.3%)
Creating digital media (video, blogs, etc.)	29 (16.7%)	56 (32.6%)
Teaching or supporting learners through technology	11 (6.4%)	82 (47.8%)

Of the 172 respondents who completed question 14 of the pre-course survey 64.5% or them were not aware of the PhET simulation portal developed by the University of Colorado.

The respondents' primary reasons for registering in TCT MOOC are provided in Table 11. The primary reason most frequently stated (67.4%) by respondents is that they wanted to learn more about PhET in chemistry teaching.

Table 11. Distribution of primary reasons for taking the course (n=172)

Response	Number	Percent
Learn more about using PhET in Chemistry teaching	116	67.4%
Professional development (contributing to your CV, for example)	45	26.2%
Obtaining a certificate	7	4.07%
Other (please specify)	4	2.3%

Over one-third of survey respondents (200, 34.7%) indicated they had previously registered in a MOOC that has been offered through the AU-COL partnership: Blended Learning Practice (138, 24.0%), Introduction to Technology-Enabled Learning (113, 19.6%), and Learning to Learn Online (also offered by Athabasca University alone; 86, 14.9%). 35 respondents (6.1%) had previously registered in all three.

Table 12. Distribution of responses to "How did you learn about this course?" (*n*=172)

Response	Number	Percent
Social media	44	25.6%
Colleagues/workplace	41	23.8%
Commonwealth of Learning website	39	22.7%
Email notification	26	15.1%
Other	11	6.4%
Commonwealth of Learning newsletter	6	3.5%
Course Brochure	5	2.9%

Across all survey respondents (*n*=172), through colleagues and the workplace (23.8%), social media (25.6%), and the Commonwealth of Learning website (22.7%) were the top most important reported sources for registrations. The distribution of responses to the question, "How did you learn about this course?" are provided in Table 12.

Question 16 of the pre-course survey asked respondents to indicate their primary reason for taking the TCT MOOC. Of respondents who answered this question, 116 of 172 or 67.4% indicated that they "Learn more about using PhET in Chemistry teaching."

The final question of the pre-course survey asked respondents to describe what they specifically hoped to get from the TCTMOOC in their own words. Several examples of responses to this question are provided below:

> *"Get relevant cutting-edge knowledge in current trends of teaching Chemistry with technology."*
>
> *To know how to plan my lessons using PhET so as to make my class more effective and interesting.*
>
> *"Influence other teachers to recognize the use of technology in teaching and learning"*
>
> *"When I first used Phet in my class to teach the change of state of matter, my students were in awe and did not want to stop watching the simulations. This activity sparked up series of discussions well after the class and they quite understood the concept more. So I hope to learn how to use more of Phet for effective lesson delivery."*

Summary of end-of-course survey results

The End-of-Course survey was completed by 130 participants. Survey responses to questions regarding general satisfaction with TCT MOOC indicate that respondents found a high level of satisfaction and confidence that the course would assist them in the use of technology – such as PhET online simulations – in their chemistry teaching. The survey results regarding participant's satisfaction with the course and content are outlined in Table 13.

Table 13. Course satisfaction and content evaluation

Survey Question	Responses	Agree or Strongly Agree	
		Number	Percent
TCT MOOC met the stated learning objectives	121	112	92.6%
The amount of time I spent on the course met my expectations	121	104	85.6%
The workload was manageable	120	108	90.0%
The pace of the course was comfortable for my learning	120	106	88.3%
The course activities reinforced the course material	120	112	93.3%
The course activities did a good job of triggering my thinking	120	110	91.7%
The course activities did a good job of holding my interest	119	106	89.1%
The course material was of good quality	120	112	93.3%
Assignments were helpful to acquire knowledge and skills	118	110	93.2%
The quizzes helped to test my knowledge	120	111	92.5%
The TCT Lesson Plan or Science Activity Worksheet helped me prepare for teaching chemistry with technology	120	106	88.3%
The TCT MOOC experience will assist me in teaching (or supporting teaching) chemistry with technology	121	112	92.6%
Overall, I was satisfied with TCT MOOC	121	113	93.4%
I would recommend TCT to other educators	121	114	92.4%

Survey responses about the instruction, facilitation, and learning community aspects of the course showed less agreement and strong agreement. TCT MOOC respondents showing an appreciation for the high levels of discussion supported by the instructor, facilitators, and their peers in the course. There was a strong sense of community developed in the course according to respondents (86.7%) who replied to that specific question. The responses to these questions are provided in Table 14.

Table 14. Evaluation of instruction and the TCT MOOC learning community

Survey Question	Responses	Agree or Strongly Agree	
		Number	Percent
I experienced direct instruction during LCTL MOOC	120	93	77.5%
My learning was supported through facilitation by the Inspirer	110	104	86.0%
My learning was supported through facilitation by the roving instructors (facilitators)	119	93	78.2%
My learning about TCT was supported through my discussions with other students	120	97	80.8%
My learning about LCTL was supported by reading other student posts	120	97	80.8%
TCT MOOC discussions provided me with information about resources that I will be able to use in my own	121	107	88.4%
I felt like I was part of a community in TCT MOOC	120	104	86.7%
It was okay to express emotion in TCT MOOC forums	121	92	76.0%

The End-Of-Course survey also allowed for an open-ended suggestion and feedback. A selection of open-ended responses is listed below.

Keep it up! It is really helpful to the chemistry teachers' community worldwide, even if many of us maybe we don't communicate enough on the forum; it is because of very demanding work we have as teachers (particularly on my side) but I have to manage and follow, try to learn more because I found this course very interesting as it will help me in my chemistry teaching. I do appreciate your work. Thank you very much, be blessed! Let's continue work together and learn from each other. Thank you.

The course was designed in such a way that it kept me motivated and engaged throughout the 5 weeks. The course was a great learning experience that helped me to reflect on my teaching pedagogies and ways to improve my teaching.

This is my first time to this online course. I loved everything and it was inspiring. Most of all, i experienced an upgrade in my teaching through this course.

It would be much better to use more live sessions to help the participants on how to manipulate most of the simulations available in chemistry

More examples and live demo of usage of Phet in classroom setting would be helpful. A live class and discussion based on the classroom activity would bring out better usage of the tool and learn from the general mistakes made.

I suggest the teaching videos should be available to download not only the slides and transcript.

Please I would request the course to be offered again. I have many colleagues who would wish to enroll for the course.

very good course. I wish that every CHEMISTRY teacher would enroll in this course. This course was so helpful to me.

A very informative course. However, I could not continue the weekly activities due to the workload I had at the university. In addition, I could not work after hours due to the power cuts we had from evening to night. I was very much interested in submitting a lesson plan. I would be thankful if you could arrange me to submit a lesson plan and get feedback to improve my teaching.

Section 5. Outcomes

The first offering of TCT MOOC was designed to achieve both knowledge and behaviour outcomes among participants related to chemistry education. The explicitly stated outcomes for this MOOC are identified in the course brochure and on the course website. By design, TCT MOOC participants are expected to:

- Identify foundational elements of chemistry teaching,
- Explore chemistry simulations and OER tools that support them,
- Identify blended learning approaches for chemistry education,
- Discuss strategies and tools for chemistry teaching with other teachers,
- Develop a Chemistry Lesson Plan integrating technology for teaching and learning,
- Evaluate a lesson plan using a pedagogical rubric.

The extent to which these outcomes were achieved by participants is assessed, at this preliminary stage of evaluation, by the level of interactions, discussion posts content, quiz results, exercise/ assignment completions, and survey responses. During the course, discussion forum posts were seen to be rich in content and complexity. In addition, a significant number of participants felt engaged enough to open their own discussion forums on topics of their choice.

Previous experience and research in distance education and online learning has identified that knowledge and behaviour outcomes are realized through participant engagement with course resources and learning activities. Activities and discussions need to be adequately supported by the instructors and facilitators as well as be engaging and meaningful enough to keep the participants returning to the course space. The TCT MOOC offered multi-modal learning activities to support participant achievement of learning outcomes. These presented learning activities, summarized in Table 15, are outlined and described to participants in the course orientation video and on the course site.

Table 15. Presented multi-modal learning activities

Activity mode	Description
View	Promotional video, Orientation video, Week 1: 7 content videos, Week 2: 5 content videos, Week 3: 4 content videos, Week 4: 3 content videos, Week 5: 2 content videos
Read	REQUIRED readings for assessment
Review	OPTIONAL readings for reference
Reflect	The reflection questions guides learners towards developing a personal response that considers content from video or readings in reference to your own competencies, goals, and/or education context.
Post	Discussion forums are divided and relate directly to the weekly activities.
Quiz completion	8 questions, 4 discussion post responses 1 quiz per week, 70% average across all quizzes, unlimited quiz attempts allowed with final score remaining as recorded score.
TCTMOOC Lesson Plan or Science Activity Worksheet	Week 4

Evidence that the course design and delivery was successful can be found throughout the course outcomes, but none speaks as loudly as the comments of participants themselves. With regards to the content of the course:

> *"I truly appreciate the presenters. Great job. Kudos. Am a PhD student in Kenya, my research study centres on use of virtual laboratory in teaching of chemistry. The course has been very helpful and resourceful. I truly appreciate [it]."*

> The course was designed in such a way that it kept me motivated, and engaged throughout the 5 weeks. The course was a great learning experience that helped me to reflect on my teaching pedagogies and ways to improve my teaching.

> The course was very well designed since the tasks were given adequate time (they did not expire throughout the course period). Furthermore, the ability to take the quiz multiple times and taking the final grade, made the course less hectic.

With regards to the instruction in the course:

> *@ Nathaniel. You are a great teacher. I like the way the course is structured and the weight of the course. Not too loaded to discourage learners especially first timers like my chemistry student teachers. They have indicated they are enjoying their first online MOOC and they are learning a lot. They have*

indicated that it is relevant to their future career. Hope all or most of my student will complete the course and will apply the acquired knowledge in future.

With regards to the facilitation within the course, participants acknowledged the significant learning support by the course facilitators. In the end-of-course survey the question "Was your learning supported through facilitation by the roving instructors (facilitators)" had agreement by 78% (93/119) of the survey respondents. The following comments further highlight the value of the facilitators' role in the course delivery:

We appreciate the efforts of the course's instructors and fellow students. To fully utilize the educational system, additional courses like this one in all academic areas are needed.

[V]ery good instructors. Always ready to teach and learn. have more information for the learners. The team are exceptional good.

One element of the TCT MOOC was the introduction of the Community of Inquiry theoretical framework as the pedagogical approach for the MOOC. Participants were introduced to the CoI early in the first week of the course with not only a description of how an online course using the model but also the role that participants need to play as learners in the community. Modelling the development of a learning community is part of the unspoken "online teaching and learning" curriculum for this course. Requirements for communication are made explicit in the Orientation Video, including the requirement to respond to the posts of others and be socially, cognitively, and teaching present during the course. More than one participant indicated they were first time online course learners, and their experience aided in their development of teaching practice in general:

This is my first time to this online course. I loved everything and it was inspiring. Most of all, i experienced an upgrade in my teaching through this course.

Future TCTMOOC Modifications

There were several very valuable comments from learners regarding future TCTMOOCs. In the videos there is several comments about the instructor being in front of the slides he was speaking to so perhaps learners should be made aware that they can download the slides.
Secondly there was a significant call for more of what really had impact – more live demonstration of teacher use. Here is a comment which speaks to this theme:

More examples and live demo of usage of Phet in classroom setting would be helpful. A live class and discussion based on the classroom activity would bring out better usage of the tool and learn from the general mistakes made.

Appendix A. TCT MOOC Information Page

https://www.mooc4dev.org/TCT

Course Description

In this course we will explore the use of the Open Access PhET Interactive Simulation software in chemistry teaching. Used by educators around the world, PhET simulations bring worthwhile technology-enabled teaching tools to the classroom. Founded in 2002 by Nobel Laureate Carl Wieman, the PhET Interactive Simulations project at the University of Colorado Boulder creates free interactive math and science simulations. PhET simulations are based on extensive education research and engage students through an intuitive, game-like environment where students learn through exploration and discovery.

In this course, the participants will explore examples (and how to develop them) of how to incorporate active learning and simulations (online or offline) that can engage their learners in chemistry education. The participants will have the opportunity to meet and discuss challenges presented in chemistry education. Chemistry and pedagogy experts will guide participants through the development of PhET simulations.

At a Glance

Schedule	08 January to 12 February 2023 (5 weeks)
Intended audience	K-12 and university chemistry teachers, student teachers, teacher educators, and instructional designers.
Language	English
Expected workload	3-5 hours per week (25 hours total)
Challenge level	Introductory
Prerequisites	None
Certification	Certificates of Participation and Completion available at no charge

Course Contents

Week 1

1.1 How online learning works and the Community of Inquiry (CoI); MOOC participant expectations.
1.2 Science teaching philosophy (Scientific Method); What is TPACK and why you should care.
1.3 OERs, Creative Commons licensing, and why they are important for teaching.

Week 2

2.1 Active learning and simulations in Science Education.
2.2 What is PhET and how does it work.
2.3 How do teachers use PhET in Chemistry.

Week 3
3.1 Blended learning for chemistry teaching.
3.2 Other technology tools you can use in chemistry teaching (e.g., Chemsketch).
3.3 Guidelines for evaluating PhET simulations in chemistry teaching.

Week 4
4.1 Planning your own simulation lesson using PhET.
4.2 Creating your chemistry simulation lesson plan and supporting student activities.
4.3 Assessment for chemistry simulations.

Week 5
5.1 Evaluating chemistry lesson plans.
5.2 Reflections on teaching chemistry with TEL.

Target Audience

This course is open to anyone, anywhere, and is mobile-friendly. TCTMOOC has been designed to assist teachers, student teachers, teacher educators, and instructional designers to plan and develop a chemistry lesson and related assessments with technology. Chemistry teachers will benefit from the exploration tools, tactics, and strategies that expand their repertoire of chemistry teaching practice using technology.

Outcomes of the course

During this MOOC, you will:

- Identify foundational elements of chemistry teaching,
- Explore chemistry simulations and OER tools that support them,
- Identify blended learning approaches for chemistry education,
- Discuss strategies and tools for chemistry teaching with other teachers,
- Develop a Chemistry Lesson Plan integrating technology for teaching and learning,
- Evaluate a lesson plan using a pedagogical rubric.

Course instructors and development and management team

COURSE INSTRUCTOR & DESIGNER

Dr. Nathaniel OSTASHEWSKI is Associate Professor of Open, Digital, and Distance Education at Athabasca University in Alberta, Canada. He taught chemistry for 18 years in grades 7-12 and utilized active learning and technology in all his science teaching. Currently Dr. Ostashewski teaches graduate courses in distance education, research design, educational technology, and online and blended learning. He has been incorporating digital technology in teaching since 1990, both at the K12 and graduate education level. Since 1995 Nathaniel has been training educators how to incorporate technology-enabled learning into "worth-it" classroom, blended, and online activities. His extensive experience with digital media for education, OERs, online and

blended instructional design/teaching strategies, and learner engagement tactics are evidenced in MOOCs he designs and teaches. Dr. Ostashewski has developed and taught several COL MOOCs such as the Introduction to Technology-Enabled Learning, Designing for Communities of Inquiry in Online Learning, and Leading Change in Teaching and Learning for a Digital World.

COURSE FACILITATORS

Prisca BYUKUSENGE completed her M.Ed. in Chemistry Education at the African Centre of Excellence for Innovative Teaching and Learning Mathematics and Sciences, University of Rwanda, College of Education. Her research focus is on computer-enabled learning. Prisca holds a Bachelor of Science in Chemistry with Education awarded from the former Kigali Institute of Education.

Jenine HAWRYLUK is a doctoral student in distance education at Athabasca University. She has taught English for Academic Purposes in Canada and Lithuania, specifically focusing on academic writing, as well as English as a Second or Other Language and facilitated teacher training in several countries. Jenine is particularly interested in pedagogical approaches used in different intercultural contexts. She has two teen foster children, loves to create macrame wall hangings, and is looking forward to traveling again in the future. Jenine has facilitated in Leading Change in Teaching and Learning for a Digital World, Blended Learning Practice, Technology-Enabled Learning, and Learning to Learn Online, and brings that experience to support you in TCT.

COURSE ADMINISTRATOR AND TECHNICAL LEAD

Dan WILTON is an instructional designer and analytics specialist for MOOCs and other online initiatives in the Faculty of Humanities and Social Sciences at Athabasca University, where he is also currently completing his doctoral studies into educational research collaboration. As your technical and participant support for TCTMOOC, he will be working closely with the instructional team to help monitor course activity and address any general questions or concerns.

ADVISER: TEACHER EDUCATION, COMMONWEALTH OF LEARNING

Dr. Evode MUKAMA joined COL as Adviser: Teacher Education on August 1, 2022. Dr Mukama has had a long career in higher education with a focus on teacher professional development in ICT-enhanced learning, pedagogical skills and digital content development. He served as Associate Professor in digital education at the College of Education, University of Rwanda. He holds a PhD in Information and Communication Technology in Teacher Education from Linköping University, Sweden, a MEd in Curriculum Studies from University of Natal, Durban, South Africa, and a BEd from National University of Rwanda, Rwanda.

Appendix B: Delivery Design of TCT MOOC

Video lectures and instructor presence

Video content was presented by Dr. Ostashewski and were included directly in the course content pages. Transcripts of the videos along with the slides show in the videos were also provided for learners. These videos constituted the direct instruction in the course, as well as creating the first level of instructor presence.

Instructor's role and presence

The Instructor's role included:

- presenting announcements to guide learners during the course (see Appendix G),
- providing a sense of direct teacher presence in the course forums and Hangout Live Chat,
- guiding the weekly facilitation team meetings to ensure cohesive messaging and support within the delivery team, and
- providing grading and feedback on the final TCT Lesson Plan or Science Activity Worksheet assignment.

The announcements provided updates on course events such as what to watch for in the current week, information about the synchronous session, as well as drawing from the course content to draw in participants into the weekly activities.

Role and presence of the facilitation team

Two facilitators were hired to support TCT MOOC in order to facilitate instructional support. The facilitators' role was to:

- review and respond to (or redirect) participant questions in the lesson activity and general forums,
- review and reply to the Live Hangout Chat discussions and queries as they were posted by participants,
- facilitate networking between participants by highlighting and including direct links to participants with similar interests or issues,
- provide expert teacher use examples of PhET simulations in chemistry education and monitor and respond to discussion the discussion forum attached to that video examples,
- review and discuss in weekly facilitation team meetings the successes and challenges seen in participant activity, and
- provide grading and feedback on the final TCT Lesson Plan or Science Activity Worksheet assignment.

Facilitation team reflections

The two facilitators hired to support TCT MOOC provided the following commentary about their facilitation experience. The first facilitator (Jenine Hawryluk) was experienced in MOOC facilitation, while the second (Prisca had not facilitated in a MOOC before.

TCT Reflections, Jenine Hawryluk, Facilitator

Discussion Posts

In terms of the MOOKit platform, I found that although it does very similar functions as Canvas does, the ability for participants to have participant generated discussion forums as an easy first choice over adding to other already created discussion forms seemed to create a distributed effect on the conversations, particularly without the option of threading conversations. As a facilitator, this meant not only reading the same comments in numerous different places, but also that I needed to repeat my commentary in several different forums. There were times when I tried to go back and add to those conversations, but it was difficult to find them again. I checked all updated forums typically every 24 hours or so, and many of those updated comments were just one or two words of thanks or agreement.
Additionally, the lack of threading [threaded discussions] meant that it was challenging to get a meaningful back and forth in posts and responses, hindering a collaborative and constructivist approach to learning.

My personal recommendation would be a more centralized flow to the commentary that included threading of discussions so that there would be efficiency in the discussion and also better elaboration on topics. I recognize that there is likely a good rationale for the choice of platform; however, I felt it was important to note how the platform may be affecting the development of understanding, and the way conversations may or may not develop.

Chemistry Simulation Focus

The fact that the group was all "speaking the same language" in terms of chemistry simulations I thought contributed to a sense of community and possibly would contribute to greater completion rates. I am curious if this would be the case. In terms of the simulations themselves, this was probably the most powerful piece of the course. This felt like a "game-changer" for many teachers who had not heard of PhETs, or who were unfamiliar with how to teach using them. Further some felt that they could not use them because they had poor internet access. However, in finding the offline access link that I tried to share liberally, they again felt that this was a game-changer for their context. I would suggest including this up front in the course in a prominent way if it isn't already. https://phet.colorado.edu/en/offline-access

I felt the focus on the instructor-led and the student-led instructional approaches were helpful for the teachers to see different ways of teaching using the simulations. The support sheets were also helpful for the participants, as were live examples (such as the video of the instructor using simulations in his class).

The live session was particularly impactful in showing the variety of sites and resources (much more than participants were likely aware of at that time). This was again one of those game-changing moments for them. I particularly appreciated Mr. Angelo Delli Santi's providing his PPT with the overview of so many resources, especially ones that the participants had been asking about (titrations). As well, the recordcing of the session was very helpful for participants to have access whenever they wanted. If possible, it would be great to have this session even earlier in the course timeline, and also to include information on how to register in the PhET site (or have that as a video piece put up as part of the resources), as well as how to access the other sites/resources.

The participants were interested in having more samples of lesson plans, and I did reiterate going through the PhET site. However, I believe that some of them were not registering and getting access to all the resources available, so I would suggest that this is heavily emphasized initially in the course so that the participants

have easy access to all that they will need in the course right away (and/or if they do leave the course at that time that they have full access to all the resources).

As well, as noted in our email exchange, there was some misunderstanding on the part of some participants that they would be creating simulations as well. I don't necessarily believe that they joined the course with the intention of learning to create the simulation (although I could be mistaken); however, especially when they found a simulation missing for what they wanted to teach with, they seemed to be wondering how to create simulations. I provided the source code link for the PhET site that we were using as it explained in an overview sense what is involved. https://phet.colorado.edu/en/about/source-code

I believe what to do when you find that there isn't a simulation to teach what you would like taught is an important point to highlight in future iterations. As this isn't my subject area, I might be off in suggesting this, but is it possible to use a more basic simulation or a simulation that teaches a similar concept, and then having a more abstract discussion with the students on the actual topic (titration was mentioned several times as not being on the PhET site), using that more basic simulation as a foundation for the discussion on titrations for example.

Summaries of the Learning and the Role

Overall, I found this a richly rewarding experience as I could see that we were having a real effect on the quality of the teaching, the quality of the teachers' lives, and positively influencing effective pedagogical choices through the approaches described. I felt that we were also addressing internet issues through offering the offline options for simulations, which felt personally meaningful as in these MOOCs I have read so much about lack of resources, and this is one way to meet that need for some. For me, the three key things that I learned through facilitating this course

a) how important it is to know the needs of the teacher and to be able to offer them something substantial towards their needs (i.e., introduction to chemistry simulations),
b) how crucial it is to find those ways to provide the access to resources that the teachers might need (offline access, how to register in the PhET site), and
c) how a practical technology application can have wider pedagogical implications (i.e., for the participants, using more of a guided discovery approach or using more collaborative learning approaches) or for myself seeing how the MOOC platform affects the way collaborative and constructivist conversations happen.

Originally, I saw my role as clarifying information where needed, responding to participant queries and pointing them in the direction of the relevant information, connecting participants to each other, asking questions to allow for deeper conversations along helpful pedagogical lines, and being a positive and warm, encouraging presence for the participants. As described above, I found it more difficult to connect participants to each other and to see much follow up to my questions. Although these are challenges typically in MOOCs, my perception was more so in this platform.

TCT Reflections, Prisca Byukusenge, Facilitator

TCT MOOC facilitation Overview

My job consisted in facilitating learning by providing responses to participants' questions and requests, create a community of inquiry by moderating the discussion forums, supporting the instructor in delivering the course, attending regularly online meetings, stay active online and provide feedback to participants' queries as soon as possible, cooperate with other facilitators to successfully complete the course and participate in a training and briefing a live session with the instructor, providing period updates to COL as well as a short report in about 500 words covering the activities and experience of facilitating the course.

Before getting into TCT MOOC (Personal experience)

I have theoretically heard about MOOC before when I was doing my Masters of Education, but TCT MOOC is my first practical experience. In one module entitled "Integration of Technology in Teaching and Learning Sciences and Mathematics", I learnt to apply different technologies in classroom settings, but the exercise was considered just as an ordinary assignment rather than a practical example of MOOC. When I heard about TCT MOOC at the first time, I thought that MOOC was just any other type of traditional face-to-face course. I was expecting the course to follow a planned timetable and that participants would meet online regularly with the instructor and the MOOC team to attend the course on specific time (may be via zoom). In this regard, I was expecting that my job would rely on providing presentations on some topics and assist the instructor in designing the quizzes, assignments and may be use specific software for marking the scripts online. At this stage, I was still wondering about how the course would look like. I was somehow uncomfortable and unconfident because I felt my language proficiency was not enough to talk with people from countries whose English is their mother tongue. In fact, I got some light of what my Job was all about when I read my job description in the contract. However, my fear and confusion disappeared gradually in practice.

During six weeks in TCT MOOC (Personal experience)

Being unfamiliar with MooKIT, I experienced some difficulties to access the course platform. When I finally managed to log in, I did not know where to start from. It took me some time to learn first how the platform functions. Thereafter I started to understand the real nature of TCT MOOC as well as the job I had to accomplish, of course, completely different from my preunderstanding. I found MOOC to be more flexible, interactive and enjoyable. As the course was unfolding, I was so surprised to realize that TCT MOOC was based a more self-paced and ubiquitous learning approach. I was excited to see how participants from all corners of the world were passionate to learning chemistry with technology while exchanging ideas in an enthusiastic mood. It was very amazing and at this step, I felt comfortable and confident with the work we were doing with them. I was not only playing the facilitation role but also, I was learning much with other TCT MOOC participants. From my colleague Jenine, I learnt a lot about how to interact with participants in the forums and I came up with posting more than 70 comments/responses to participants' questions and queries in various forums and in the hangout page. Sometimes, I have been challenged by weak and unstable internet connectivity from my end. Leading to some delays staying online and inadequate communication during the live meetings. If there is a chance to facilitate another MOOC session, I'm confident to improve my connectivity by changing the internet provider and adapting family issues.

Experience on how the development of the Video on PhET simulation went and follow up of the corresponding discussion forum

During the course, I was asked to facilitate one live course presentation. However, due to the instable internet connectivity in my location, we came up with an idea of developing a video on that topic, which was later shared with participants in the Resource page. The development of a video was a new exercise that I was expecting to be simple. Conversely, I realized that it was quite demanding. Firstly, I used a domo builder

software downloaded and installed in my computer, but I failed to export a video record. Next, I tried other screen recorder software (such Camtasia) but I missed a free version that can allow me to do many trails. Lastly, a friend advised me to try zoom. With zoom, I did many trails and finally I came up with a simple video that was later uploaded in the Resource page and a corresponding discussion forum was also added.
Drawing from the participants' comments in the discussion forum, it seems that the video has been helpful to their learning. Some participants mentioned that they enjoyed the presentation; for them, it was fascinating, impactful and educative. Some of them revealed that the session added a new dimension to their way of teaching chemistry; others reported that they decided to go and practice technology in their chemistry classes. While others said that the session has widened their understanding of how chemistry teachers can use PhET simulations in classroom.

Three top lessons learned in the TCT MOOC

a. I gained an experience on how MOOC looks like, how it works and I became more interested with digital learning;
b. I got some skills on exploration of PhET simulations and how to properly integrate them in chemistry teaching and learning;
c. I learnt how the facilitation of online learning can be done; how to maintain online students actively engaged in learning science with technology and how to create a community of inquiry among them.

Some recommendations for future

a. Most participants highly commended the course and many of them requested that there must be more frequent MOOC for Chemistry and other science subjects so as to refresh their way of teaching sciences;
b. Some participants mentioned that PhET simulations are not enough to cover all content to be taught in chemistry classroom and requested for additional MOOC sessions with a focus on how to develop their own simulations.

Appendix C: Synchronous Session

1 Feb 2023 **PhET Use in Chemistry Teaching**
Host: Dr Nathaniel Ostashewski, Athabasca University
Presenters: Mr. Kelly Johnson
Mr. Angelo Delli Santi

https://youtu.be/bPLnLRmcvwU

Announcement & Description of Session

Live Session Tomorrow February 1, 2023 6:00 PM MST
Hello everyone and we hope that you will be able to attend the Week 4 Live session with our two Chemistry teachers who will share with you how they use PhET in chemistry teaching. This live session details are as follows:
Live Session Wednesday February 1, 2023. at 6:00 pm MST (Mountain Standard TIme - Use this link to check the time this session will occur in your location).
Here is the ZOOM link:
[Zoom link removed for this report]

In this session chemistry teachers Mr. Kelly Johnson & Mr. Angelo Delli Santi will present and be able to answer questions you might have about PhET in chemistry education.

Mr. Kelly Johnson has been teaching chemistry in a Cold Lake, Alberta high school setting for 26 years and has experience with using PhET simulations to support his teaching. In the session he will be sharing how he uses the following PhET simulations in teaching the chemistry solutions unit.

- Chem 20 /grade 11 chem https://phet.colorado.edu/en/simulations/concentration
- Chem 20 / grade 11 https://phet.colorado.edu/sims/html/gases-intro/latest/gases-intro_en.html

Mr. Angelo Delli Santi has just recently completed his Master of Distance Education from Athabasca University and is continuing to learn more skills of the teaching profession at Lakehead University. He resides in Red Deer, Alberta, and teaches high school online science courses (Biology, Chemistry, Physics, and General Sciences) in a blend-ed environment at a local high school for the last 6 years. He has a passion for learning new technology tools regularly so his students can benefit from being 21st-century learners.

- During the presentation, he will show how an asynchronous Chem teacher can benefit using simulators to get students a feel of how an actual lab works. Although it should be stressed that high school students need direction with these simulators - and this is where PhET provides worksheets for students.

We hope you can join us for this informative session! (which we will record if you cannot attend)

Appendix D. TCT MOOC Brochure

Teaching Chemistry with Technology (exterior)

MEET THE COURSE TEAM

COL Lead: Dr Evode Mukama

Lead Instructor: Dr Nathaniel Ostashewski

Technical Assistant: Daniel Wilton

Teaching Assistants:
Prisca Byukusenge and Jenine Hawryluk

Lead Instructor bio:

Dr Nathaniel OSTASHEWSKI is Associate Professor of Open, Digital, and Distance Education at Athabasca University in Alberta, Canada. He taught chemistry for 18 years in grades 7-12 and utilized active learning and technology in all his science teaching. Currently Dr Ostashewski teaches graduate courses in distance education, research design, educational technology, and online and blended learning. He has been incorporating digital technology in teaching since 1990, both at the K12 and graduate education level. Since 1995 Nathaniel has been training educators how to incorporate technology-enabled learning into "worth-it" classroom, blended, and online activities. His extensive experience with digital media for education, OERs, online and blended instructional design/ teaching strategies, and learner engagement tactics are evidenced in MOOCs he designs and teaches.

CERTIFICATION

Two levels of certification are available based on your level of participation and completion of tasks/activities:

- **Certificate of Participation:** requires 70 per cent or more on each quiz and participation in at least three discussion forums.
- **Certificate of Completion:** requires 70 per cent or more on each quiz, participation in at least three discussion forums, and successful completion of a TEL Chemistry Lesson Plan.

Certificates are made available at no charge as verifiable PDF documents.

REGISTRATION

For further information and registration, go to:
https://www.mooc4dev.org/TCT

TCT inquiries: tct@colfinder.org

Commonwealth of Learning
Ms Karmila Harder
Programme Assistant
4710 Kingsway, Suite 2500
Burnaby, BC
V5H 4M2 CANADA
https://www.col.org
email: TeacherEducation@col.org

COMMONWEALTH of LEARNING

MOOC

Teaching Chemistry with Technology

08 January to 12 February 2023

LEARNING FOR SUSTAINABLE DEVELOPMENT

Teaching Chemistry with Technology (interior)

COURSE OVERVIEW

In this course we will explore the use of the Open Access PhET Interactive Simulation software in chemistry teaching. Used by educators around the world, PhET simulations bring worthwhile technology-enabled teaching tools to the classroom. Founded in 2002 by Nobel Laureate Carl Wieman, the PhET Interactive Simulations project at the University of Colorado Boulder creates free interactive math and science simulations. PhET simulations are based on extensive education research and engage students through an intuitive, game-like environment where students learn through exploration and discovery.

In this course, the participants will explore examples (and how to develop them) of how to incorporate active learning and simulations (online or offline) that can engage their learners in chemistry education. The participants will have the opportunity to meet and discuss challenges presented in chemistry education. Chemistry and pedagogy experts will guide participants through the development of PhET simulations.

During this MOOC, you will:

- Identify foundational elements of chemistry teaching;
- Explore chemistry simulations and OER tools that support them;
- Identify blended learning approaches for chemistry education;
- Discuss strategies and tools for chemistry teaching with other teachers;
- Develop a Chemistry Lesson Plan integrating technology for teaching and learning;
- Evaluate a lesson plan using a pedagogical rubric.

WHO SHOULD TAKE THIS COURSE

This course is open to anyone, anywhere, and is mobile-friendly. This TCT MOOC has been designed to assist teachers, student teachers, teacher educators and instructional designers to plan and develop a chemistry lesson and related assessments with technology. Chemistry teachers will benefit from the exploration tools, tactics and strategies that expand their repertoire of chemistry teaching practice.

AT A GLANCE

Schedule	08 January to 12 February 2023
Intended audience	K-12 and university chemistry teachers, student teachers, teacher educators and instructional designers
Language	English
Duration	5 weeks
Expected workload	3 to 5 hours per week (25 hours in total)
Challenge level	Introductory
Prerequisites	None
Certification	Certificates of Participation or Certificate of Completion at no charge

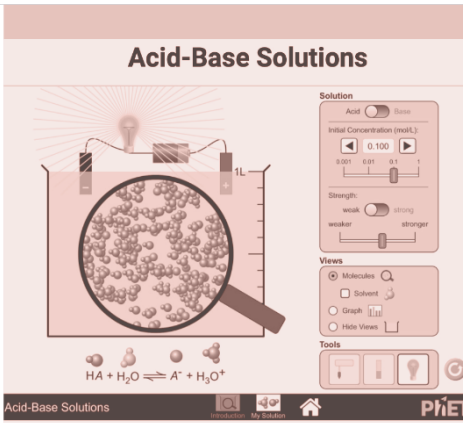
COURSE OUTLINE

Week 1

1.1 How online learning works for this course (COL) and MOOC participant expectations.

1.2 Science teaching philosophy (Scientific Method), What is TPACK and why you should care.

1.3 OERs, Creative Commons licensing and why they are important for teaching.



Week 2

2.1 Active learning and simulations in Science Education.

2.2 What is PhET and how does it work.

2.3 How do teachers use PhET in Chemistry.

Week 3

3.1 Blended learning for chemistry teaching.

3.2 Guidelines for evaluating PhET simulations in chemistry teaching.

Week 4

4.1 Planning your own simulation lesson using PhET.

4.2 Creating your chemistry simulation lesson plan and supporting student activities.

4.3 Assessment for chemistry simulations.

Week 5

5.1 Evaluating chemistry lesson plans.

5.2 Reflections on teaching chemistry with TEL

DIGITAL TEACHING • SCIENCE • LEARNING TRANSFORMATION • MOOC

Appendix E. Lesson Plan or Activity Worksheet: Templates

Lesson Plan Template

Overview of the Lesson	
Subject:	Grade:
Prerequisite Skills: (What do students need to know in order to do this)	
General information regarding students & classroom context:	
Learning Goals: • See the "Writing Learning Goals" document in Activity 4.1 • •	
Simulation Used: • Based on the PhET Simulation Selection you made	
Estimated Time:	
LESSON Title	
Pre-Lab	**x minutes**
Open Play Time (if students have access to devices)	**x minutes**
Teacher will…	*Students will…*
Sim-centered Activity	**x minutes**
Teacher will…	*Students will…*

Discussion and Summary	**x minutes**
Teacher will…	*Students will…*
Resources needed:	

Science Activity Template

Learning Goals
1-3 learning goals per student worksheet

Pre-lab Activity
What kind of questions will you include here to make students aware of their prior knowledge and experiences related to the new topic? Remember that the pre-lab can be either an independent document for students to provide answers to, an oral activity with multiple-choice Conceptual Questions, or open questions.

Open Play
Allow 5 min to play with the PhET sim. Name and give a link to the simulation (select a specific screen or screens depending on the topic). Describe three main things you have discovered:

Collect and Interpret Data
Apply the tips described in the PhET Virtual Workshop to write this part. Include all the activities that will be used to guide the way students will interact with the sim, help them collect and organize data, identify relationships, and build conclusions.

- Make use of the simulation features by posing open questions and challenge prompts.
- Avoid giving explicit instructions on how to use the simulation.
- Generate learning scaffolding, using tables if appropriate.
- Include team and group review moments, if being used during class time.

Post-lab Activity
What kind of questions would you include so that the students can assess their understanding after the activity? Remember that the pre-lab can be either an independent document for students to provide answers to, an oral activity with multiple-choice Conceptual Questions, or open questions.

Appendix F. Pre-Registrants by Country

Country	Number (n=1301)	Percentage
Kenya	275	21.14%
Nigeria	162	12.45%
Fiji	146	11.22%
India	126	9.68%
Rwanda	109	8.38%
Tamil Nadu	83	6.38%
Ghana	33	2.54%
Trinidad & Tobago	29	2.23%
Uttar Pradesh	22	1.69%
Andhra Pradesh	17	1.31%
Jammu and Kashmir	17	1.31%
Canada	16	1.23%
Tanzania	16	1.23%
Zambia	15	1.15%
Swaziland	13	1.00%
Mauritius	13	1.00%
Bangladesh	12	0.92%
Maharashtra	11	0.85%
Pakistan	10	0.77%
Botswana	9	0.69%
Vanuatu	7	0.54%
Uganda	7	0.54%
Sri Lanka	6	0.46%
Gambia	6	0.46%
West Bengal	6	0.46%
Haryana	6	0.46%
Belize	6	0.46%
Jamaica	6	0.46%
Botswna	6	0.46%
Delhi	5	0.38%
Indonesia	5	0.38%
Malawi	5	0.38%
Orissa	5	0.38%
Sierra Leone	4	0.31%
Tonga	4	0.31%
Tanzaia	4	0.31%
United States	4	0.31%

Rajasthan	4	0.31%
Malaysia	4	0.31%
St Kitts & Nevis	4	0.31%
South Africa	4	0.31%
Namibia	4	0.31%
Samoa	3	0.23%
Kiribati	3	0.23%
Bihar	2	0.15%
Telangana	2	0.15%
Guyana	2	0.15%
Kerala	2	0.15%
Madhya Pradesh	2	0.15%
Karnataka	2	0.15%
Zimbabwe	2	0.15%
Cameroon	2	0.15%
Uttarakhand	2	0.15%
St Vincent and the Grenadines	2	0.15%
Liberia	2	0.15%
Papua New Guinea	2	0.15%

One registrant joined from each of the following countries:

Mexico	Philippines	Chhattisgarh	Mali
Australia	Poland	Maldives	Central African Rep
Germany	Taiwan	Romania	Switzerland
Tripura	Afghanistan	Solomon Islands	United Kingdom
Sweden	Assam	Ethiopia	Jordan
China	Marshall Islands	New Zealand	Punjab
Tunisia			

Appendix G. Course Announcements

Course Announcements

As with any online course, announcements are an integral part of the design and management of activities that are being presented to learners in a MOOC. In the TCT MOOC a total of 17 announcements – originating either from the Course Administrator or the Course Instructor – were sent to participants. Below is a listing of the titles of these announcements and the dates they were sent to participants in the course.

▶ Final hours for quizzes and lesson plan submissi...	25/2/2023
▶ TCTMOOC assessments extended until Feb 25th Midn...	20/2/2023
▶ Final week continues until Feb 19th	15/2/2023
▶ TCTMOOC continues for several more days!	14/2/2023
▶ Week 5 Quiz & Course Certificate Requirements	11/2/2023
▶ Week 5 and TCTMOOC course is extended one more w...	7/2/2023
▶ Week 5 of TCT MOOC is now open	4/2/2023
▶ Live Session Tomorrow February 1, 2023 6:00 PM MST	31/1/2023
▶ Week 4 Live session and more!	29/1/2023
▶ Week 4 of TCT MOOC is now open	28/1/2023
▶ Week 3 of TCT MOOC is now open	22/1/2023
▶ Week 2 Quiz Open now	21/1/2023
▶ Week 2 Continues	19/1/2023
▶ Week 2 of Teaching Chemistry wiith Technology is...	15/1/2023
▶ Week 1 Quiz and TCTMOOC Navigation Video	12/1/2023
▶ Week 1 Activity Pages and Course Navigation Assi...	11/1/2023
▶ Teaching Chemistry with Technology is now open	8/1/2023

Course Announcement Examples

We provide representative course announcements sent to participants during the course.

Announcement #1 -Teaching Chemistry with Technology is now open

> **Welcome to Teaching Chemistry with Technology!**
>
> Week 1 of TCT MOOC is now open, beginning with a focus on effective teaching and learning with technology, before moving on to look at Chemistry in particular.
>
> To begin, log into TCT MOOC here:
> https://www.mooc4dev.org/tct
>
> *How to find your way around:*
>
> Each week will include two or three key topics, divided into a set of video presentations by **Dr. Nathaniel Ostashewski** of Athabasca University. You will find an **Activity Sheet** for each topic available for download on the **Resources** page; each Activity Sheet includes a number of readings, web explorations, and more for you to complete. Each set of activities ends with a discussion question; you will find these discussion forums under the last video for each topic, or through the Lectures tab on the **Forums** page.
>
> As a first step, look for the Pre-Course Survey under the *Welcome to TCT* message in the General Forums. Then be sure to introduce yourself in these forums by creating your own new topic or replying to others. As the course goes on, you will also be able to use the General Forums to raise your own topics around teaching Chemistry with technology, asking questions and sharing your experience with your fellow participants from around the world.
>
> On behalf of the TCT instructional team, enjoy the course!

Announcement #5 -Week 2 Continues

> Week 2 Continues
>
> Hello everyone and it is so nice to see many of you have found your way around the TCTMOOC space. We hope that you are finding the conversations and activities worthwhile as we know that fitting this course into busy schedules can be challenging. With that in mind, please do keep working along with us as you are able and know that you can complete any forums or quizzes at any time in the course.
>
> Of particular note - we would like you to know that we have made the RESOURCES page the primary page for launching all of the activities and from there you can navigate to wherever in the course you happen to be at. Use the links to find the forums and even the quizzes. Quiz 2 will be released tomorrow, and our intent is that the quiz helps you review the weekly materials as well as provide key points that we believe are important from the weekly resources.

Good luck and see you in the forums.
Dr Ostashewski, TCTMOOC Instructor

Announcement #9 -Week 4 Live Session and more!

Week 4 Live session and more!
Hello everyone and I hope that you are finding the resources in the course useful and discussions meaningful. We have just begun week 4 in this 5 week MOOC, and I wanted to highlight some of this week's events.
1) In week 4 the course continues to highlight PhET uses in chemistry education, and in Activity 4.3 we share some of the top online chemistry resources that can be used to support blended learning in your classroom. Don't miss these 4.3 resources!
2) Live Session Wednesday February 1, 2023. at 6:00 pm MST (Mountain Standard TIme - Use this link to check the time this session will occur in your location). In this session chemistry teachers Mr. Kelly Johnson & Mr. Angelo Delli Santi will share their PhET experiences both in the classroom and online settings. Join us for a one hour live session via ZOOM. The Zoom link will be posted 5 hours prior to the live session (see the RESOURCES page for details)
3) Week 3 quiz is posted last week - and week 4 quiz will be available after the Live Session on Wednesday. Please do take the quiz as many times as you like - your last grade will be the one that is recorded. Also if you are stuck on quiz questions, we suggest you review the Slides for each of the videos (see them on the Resources page).
With that - see you online in the discussion forums and in the live session (which will be recorded if you cannot attend).
Dr. Ostashewski

Announcement #14 -TCTMOOC continues for several more days!
Hello and it is excellent to see the participation of so many of you with this course - thank you for your participation as that is what makes it valuable for all of us.

If you have not yet completed the 5 course quizzes - please do take the time so that you are eligible for the Certificate of Participation. I note that 75 of you have already uploaded the Lesson Plan OR Worksheet assessment in addition to the quizzes. Well done and the additional time this week is to allow more of you to complete all the assessments.

The discussions will continue to be open this full week - so please do join in and if you need more urgent assistance, please use the Hangout chat tool to post a question - as our facilitators can easily find and reply to your technical questions.

If you are done (or nearly done) the course we would really appreciate your participation in our Course Exit Survey - we would like to hear back from you about our TCTMOOC design to be able to

improve it for future deliveries. Here is the link to the survey (https://www.surveymonkey.com/r/tct1-end) which can also be found in Week 5 resources page.

On another note - there is another upcoming MOOC that we are offering beginning March 12th - the DCOI MOOC - Designing for Communities of Inquiry in online (and blended) courses. In this course we spend 5 weeks diving into the Community of Inquiry framework (see https://www.thecommunityofinquiry.org/) and how to use it in the support of digital technology-enabled learning. Join us and please share this with your colleague networks!

With that - see you online!
Dr. Ostashewski

Appendix H. Survey Letter of Consent

Pre-course Survey: Teaching Chemistry with Technology

Participant consent form

20 November 2022

Dear Participant:

We are researchers at Commonwealth of Learning and Athabasca University. We invite you to participate in a research study entitled "Teaching Chemistry with Technology". The purpose of this study is to create a detailed picture of the participant experience in this MOOC.

Your participation will involve completing two short surveys: one at the beginning of the course and one after the course has finished. Each survey will take between 5 and 10 minutes to complete. Some participants may also be contacted for a more detailed interview, should you be willing to do so. This interview takes between 15 and 20 minutes in total.

Data about your general course participation, such as the assignments you submit and the time spent on different course activities, is also of interest to us. Your involvement in the study is voluntary, and you may choose not to participate or to stop at any time without penalty or loss of benefits to which you are otherwise entitled. If you decide to stop or withdraw from the study, the information/data collected from or about you up to the point of your withdrawal will be kept as part of the study and may continue to be analyzed.

In either case, all information collected in this study will remain confidential. No individually-identifiable information about you, or provided by you during the research, will be shared outside the research/instructional team without your written permission. All research data will be kept on a secure drive for which only the principal researchers and instructional assistants will have access. Identifying information of participants will be removed from any reports that are seen by anyone other than the principal researchers and instructional assistants. The results of the research study may be published but your name or any identifying information will not be used. The published results will be in summary form only.

The findings from this project may provide information on how to improve the quality of learning experiences in other online courses. There are no known risks or discomforts associated with this research. If you have any questions about this research project, please feel free to contact Dr. Nathaniel Ostashewski via email at nostashewski@athabascau.ca. This study has been reviewed by the Athabasca University Research Ethics Board. Comments or concerns regarding your treatment as a research participant should be directed to the Office of Research Ethics at 1-800-788-9041, ext. 6718 or via email at rebsec@athabascau.ca.

Use the buttons below to indicate whether you agree to participate in the research project described above. To correlate the surveys with your general course participation, we will also require the email address you used to register in TCTMOOC. If you choose to consent to a follow-up interview, we may use this email address to contact you; your email address will not be used for any other purpose or shared with anyone outside the research team. Please download and print a copy of this letter for your records.

End-of-Course Survey: Teaching Chemistry with Technology

Participant consent form

8 January 2023

Dear Participant:

We are researchers at Commonwealth of Learning and Athabasca University. We invite you to participate in a research study entitled "Teaching Chemistry with Technology". The purpose of this study is to create a detailed picture of the participant experience in this MOOC.

Your participation will involve completing two short surveys: one at the beginning of the course and one after the course has finished. Each survey will take between 5 and 10 minutes to complete. Some participants may also be contacted for a more detailed interview, should you be willing to do so. This interview takes between 15 and 20 minutes in total.

Data about your general course participation, such as the assignments you submit and the time spent on different course activities, is also of interest to us. Your involvement in the study is voluntary, and you may choose not to participate or to stop at any time without penalty or loss of benefits to which you are otherwise entitled. If you decide to stop or withdraw from the study, the information/data collected from or about you up to the point of your withdrawal will be kept as part of the study and may continue to be analyzed.

In either case, all information collected in this study will remain confidential. No individually-identifiable information about you, or provided by you during the research, will be shared outside the research/instructional team without your written permission. All research data will be kept on a secure drive for which only the principal researchers and instructional assistants will have access. Identifying information of participants will be removed from any reports that are seen by anyone other than the principal researchers and instructional assistants. The results of the research study may be published but your name or any identifying information will not be used. The published results will be in summary form only.

The findings from this project may provide information on how to improve the quality of learning experiences in other online courses. There are no known risks or discomforts associated with this research. If you have any questions about this research project, please feel free to contact Dr. Nathaniel Ostashewski via email at nostashewski@athabascau.ca. This study has been reviewed by the Athabasca University Research Ethics Board. Comments or concerns regarding your treatment as a research participant should be directed to the Office of Research Ethics at 1-800-788-9041, ext. 6718 or via email at rebsec@athabascau.ca.

Use the buttons below to indicate whether you agree to participate in the research project described above. To correlate the surveys with your general course participation, we will also require the email address you used to register in TCTMOOC. If you choose to consent to a follow-up interview, we may use this email address to contact you; your email address will not be used for any other purpose or shared with anyone outside the research team. Please download and print a copy of this letter for your records.

Thank you.

Sincerely,
Nathaniel Ostashewski, EdD, Associate Professor of Education Innovation, Athabasca University

Appendix I. Pre-Course Survey

Where do you live?

- Europe/UK
- North America
- Caribbean/Central America
- South America
- South Asia/Indian subcontinent
- Asia
- Oceania
- Middle East
- Africa

Please specify your country.

What is your primary spoken language?

- English
- Other (please specify)

What is your gender?

- Male
- Female
- Other or non-binary
- Prefer not to answer

What is your age group?

- Under 20
- 20-29
- 30-39
- 40-49
- 50-59
- 60 or over

What is your highest educational qualification?

- Secondary/high school diploma
- College certificate or diploma
- Vocational school certificate or diploma
- Bachelor degree or equivalent
- Master degree or equivalent
- Ph.D. or equivalent

What is your teaching experience?

- Currently a student
- Less than 5 years

- 6-15 years
- 16-25 years
- More than 25 years

What does your job involve? (select all that apply)

- Face-to-face teaching
- Distance or online teaching or facilitating
- Blended/hybrid teaching (face-to-face and distance or online)
- Work-based training
- Research
- Leadership/management/administration
- Government service
- Education support services
- Other (please specify)

If your job involves teaching, at which levels do you teach? (select all that apply)

- Early education/elementary/primary school
- Secondary/high school
- College
- Vocational school
- University
- Workplace/military/community
- Other (please specify)

How would you rate your current skill level when performing the following tasks? (none, basic, proficient, or advanced)

- Acting as a leader in formal or informal situations
- Using digital tools for teaching
- Using digital tools for learning
- Supporting new technology and pedagogy for teaching and learning

How did you find out about this course?

- Commonwealth of Learning website
- Commonwealth of Learning newsletter
- Course brochure
- Athabasca University
- Notification in a previous MOOC
- Email notification
- Social media
- Colleagues/workplace
- OpenUpEd
- PCF conference
- Other (please specify)

What is your primary reason for taking this course?

- General interest, primarily in digital teaching and learning
- General interest, primarily in educational leadership
- General interest, primarily in MOOCs
- Professional development (contributing to your CV, for example)

- Obtaining a certificate
- Other (please specify)

If you earn a certificate for this course, will you be applying it as professional development hours to further your career or meet professional development requirements?

- Yes
- No
- Does not apply

Which of the following best describes your intention to complete this MOOC?

- To browse the course contents, but not planning to complete the course
- Planning to complete some course activities, but not planning to earn a Certificate of Completion
- Planning to complete all activities to earn a Certificate of Completion
- Have not decided whether I will complete any course activities

What do you specifically hope to get from your engagement in this course that will support your science or chemistry teaching?

Do you consent to be contacted to participate in a follow-up interview as indicated in the consent form?

- Yes, I consent to be contacted
- No, I do not consent to be contacted

Appendix J. End-of-Course Survey

Do you consent to participate in the research study described above?

- Yes, I have read and understood the letter and consent
- No, I do not consent

If you consent to this survey, please enter the email address you used to register for TCT MOOC.

Which weekly activities did you complete or do you expect to complete? (Please select all that apply.)

- Less than one week
- Week One activities, discussions, and quiz
- Week Two activities, discussions, and quiz
- Week Three activities, discussions, and quiz
- Week Four activities, discussions, and quiz
- A TCT Lesson Plan or Science Activity Worksheet.

Please provide us with your feedback by indicating your level of agreement to the following statements.

- TCTMOOC met the stated learning objectives
- The amount of time I spent on the course met my expectations
- The workload was manageable
- The pace of the course was comfortable for my learning
- The course activities reinforced the course material
- The course activities did a good job of triggering my thinking
- The course activities did a good job of holding my interest
- The course material was of good quality
- Assignments were helpful to acquire knowledge and skills
- The quizzes helped to test my knowledge
- The Leadership Activity Plan helped me prepare for transformative leadership toward digital teaching and learning
- I experienced direct instruction during TCT MOOC
- My learning was supported through facilitation by the Inspirer
- My learning was supported through facilitation by the roving instructors (facilitators)
- My learning about TCT was supported through my discussions with other students
- My learning about TCT was supported by reading other student posts
- TCT MOOC discussions provided me with information about resources that I will be able to use in my own leadership
- I felt like I was part of a community in TCT MOOC
- It was okay to express emotion in TCT MOOC forums
- The course website was user-friendly
- The Welcome Module helped me navigate the course and understand course expectations
- The TCT MOOC experience will assist me in supporting the use of digital technology for teaching and learning
- Overall, I was satisfied with TCT MOOC
- I would recommend TCT to other educators

Please indicate the level of instructor and facilitator involvement you would have liked to have had in TCT MOOC.

- Much more instructor and facilitator involvement
- Somewhat more instructor and facilitator involvement
- About the same level of instructor and facilitator involvement
- Less instructor and facilitator involvement
- I felt no need for instructor or facilitator involvement

What suggestions do you have for the instructor and/or course design team?
If you would like to provide general feedback on TCT MOOC, please enter it here.