Interest-driven STEM learning among youth through a social networking site

Michael A. Evans* and Samantha G.L. Won

Department of Learning Sciences and Technologies,
Virginia Tech,
306 War Memorial Hall (0313),
Blacksburg, VA 24061, USA
E-mail: mae@vt.edu
E-mail: moocowz@vt.edu
*Corresponding author

Tiffany Drape

Office of Educational Research and Outreach,
Virginia Tech,
East Eggleston, Room 217,
500 Drillfield Drive, Blacksburg, VA 24061, USA
E-mail: tdrape@vt.edu

Abstract: Engaging middle school youth in STEM curricula resulting in desired conceptual changes is challenging. Furthermore, social media are identified as platforms where youth naturally congregate for sustained interaction. Studio STEM was designed as an after school programme to engage learners (ages 11–15) in design-based science inquiry within a studio environment, enhanced by social media and digital tools. In the highlighted curriculum, Save the Penguins, youth performed scientific experiments and engineering practices to design an enclosure to protect penguin-shaped ice cubes from rising temperature. Researchers tracked attendee and facilitator interactions through the social networking site, Edmodo. Results assert that youth's understanding of science concepts was enhanced through participation in Studio STEM, evidenced through their articulation of understanding through Edmodo. Articulation remained dependent upon the amount of prompting that facilitators used within the Edmodo site as well as the availability of time set aside for students to interact with Edmodo.

Keywords: conceptual change; discursive psychology; engagement; facilitation strategies; engineering education; informal learning; problem-based learning; engagement; middle school youth; social media; integrative STEM education.

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Biographical notes: Michael A. Evans is the Principal Investigator for the Studio STEM Project, researching adoption and use of social media for informal STEM learning.

Samantha G.L. Won is a first-year doctoral student researching the role of social media in teaching and learning.

Tiffany Drape is the Project Manager for Studio STEM through the Office of Educational Research and Outreach, researching teacher preparation and how educators integrate technology into their classrooms.

1 Introduction

The acronym STEM stands for science, technology, engineering, and mathematics – fields of inquiry and practice deemed a priority given increasing global workforce demands. Evidence is unclear as to why STEM fields are not being pursued by youth during school age years. Proposals identify a lack of authenticity allowing youth to relate to the material, or perhaps that the instructional style for these subjects does not promote problem solving and inquiry (Anastapoulou et al., 2011). Developing alternative interventions to motivate and interest youth in learning about STEM concepts could be of potential benefit, while documenting results could significantly contribute to extant research.

A line of intervention by which educators attempt to engage youth in STEM is through the development of after-school programmes and informal learning settings (Bell et al., 2009). Many of these new curricula emphasise the use of problem-based learning to make material relevant and interesting to youth (Hmelo et al., 2000). A variety of factors have been found to influence youth involvement with after-school programmes. Specifically, the availability of support and strong relationships with facilitators or peers, feeling of safety, and opportunities to learn play a large role in student participation (Strobel et al., 2008). The Studio STEM Save the Penguins curriculum, originally developed by Schnittka and Bell (2011), is an example of a programme geared towards appropriately engaging middle school aged youth in the concepts of heat transfer and engineering practice through inquiry. College faculty, practicing engineers, and graduate and undergraduate students provide facilitation on-site. The incorporation of hands on maker-like projects and experiments is meant to reinforce the knowledge presented in an introductory lecture presentation format.

2 Literature review

Barron et al. (1998) developed the special multimedia arenas for refining thinking (SMART) model to conceptualise designing and implementing effective problem-based learning curricula. Similar to Save the Penguins, SMART curricula involve a project design and redesign process that is meant to provide youth the opportunity to iteratively assess what is effective and what is not. Projects were scaffolded through the facilitation of teachers and other youth within project groups. Through participation in the SMART curriculum, youth appeared to learn with understanding and reported that they felt the project was important and interesting.

Informal learning programmes not only involve spending extracurricular time at the school, but also interaction with STEM concepts at home through the use of age-appropriate social media. Social media are popular among youth for personal use (Ito et al., 2013). As such, there is potential for the use of social media in connecting formal classroom learning with informal learning and inquiry (Chen and Bryer, 2012; Hung et al., 2012). Social media provide ways for youth to articulate learning and to take control of their learning environment (Hung et al., 2012). Social networking sites in particular can be examined through many different lenses. For example, they can be explored as a tool to enhance learner understanding, a support technology for incorporation into current pedagogy, or as an informal extension of the learning environment (Merchant, 2012). Through their interactions with peers, instructor, and technology, they are able to customise their learning experience allowing a sense of control not often available in the formal classroom (Dabbagh and Kitsantas, 2012). This added control might increase youth interest in the learning environment, while preventing feelings of powerlessness in regards to new or more difficult information (Lerman, 2001). The challenge to broader adoption appears to lie in that educators lack the necessary skills and confidence in their ability to integrate technologies such as social media into their curriculum successfully (Campbell et al., 2010). This issue may be true of many technologies being incorporated into classrooms today. Nonetheless, the potential for increasing youth participation and interest in STEM topics might outweigh the cost of extra support systems and training required for educators to implement these strategies. A study performed with undergraduate pre-service teachers examined digital literacy, or the comfort level that they had with various technologies. Explicit instruction involving technology increased digital literacy, showing that these training programmes types could have a positive impact with new teachers who may not have had strong digital literacy from the beginning (Ng, 2011).

Studio STEM incorporates an age-appropriate social networking site (Edmodo ©2013) to enhance and extend the curriculum developed by Schnittka and Bell (2011). According to Kolodner et al. (2003), it is important for youth to engage in the exchange of ideas throughout the design process. Critical points include experimentation phases and implementation phases. The inclusion of social media was meant to capture ideas along these phases throughout the programme. Moreover, this additional channel of communication allowed researchers opportunities to examine changes in youth discourse related to STEM, and specifically for Studio STEM to heat transfer and engineering concepts.

Thus, the objective of this study was to investigate whether participation in Studio STEM increased youth understanding of science concepts focusing primarily on the exchanges through social media. The HOMAGO model developed by Ito et al. (2010), describing three distinct genres of youth participation as mediated by technology: *hanging out*, *messing around*, and *geeking out*, was appropriated for the analytical lens. *Hanging out* describes interactions with technology geared towards developing social relationships with peers. *Messing around* describes interactions with technology for the purpose of informally seeking information of interest to the individual. Finally, *geeking out* describes interactions with technology that are specifically directed towards increasing individual expertise and knowledge of a particular subject area of interest. Since the model specifically applies to youth and technology, HOMAGO is appropriate to frame analyses of text-based discourse through the social networking site, Edmodo.

The research questions to guide the investigation were as follows:

1. Do youth come to change understandings of science through Studio STEM, particularly through interactions via social networking sites?
2. Do interactions through social networking sites depict changes to understanding?
3. What forms of engagement occur through social networking sites during Studio STEM?

3 Methods

This study seeks to explore the changes in youth's engagement with and conceptual understanding of science related topics using principles of discursive psychology as a methodological orientation. Discursive psychology describes language as situational, action oriented and constructive (Roth, 2008). Changes in the use of language may then be indicative of changes in youth engagement and understanding. Discourse during the course of Studio STEM was analysed specifically in relation to purpose, consistent with the action-oriented function of language.

3.1 Participants

Participants in Studio STEM were youth from a rural middle school in Southwest Virginia. Studio STEM was implemented as an afterschool programme over the course of six weeks with one 90-minute session per week. At the study site, a site leader (the teacher responsible for the curriculum), a project manager (a faculty member from the local university), two undergraduate student researchers, and two undergraduate student facilitators were present each week to assist with the facilitation of the sessions.

3.2 Studio STEM programme

The Save the Penguins curriculum is designed to increase middle school youth's understanding of heat transfer (conduction, convection, radiation) and thermodynamics. Youth are introduced to background information about the impact of climate change on the natural habitats of penguins. Information is presented briefly at the start through the use of lecture presentation technology with embedded video clips, audio, and images. The presentation encourages youth to think critically about the impact of human-made technologies on the planet. Science concepts of conduction, convection, and radiation are also conveyed in the form of hands-on experiments, designed to demonstrate tangibly what has been covered previously in an abbreviated lecture format. Youth are then presented with the challenge of designing and constructing a penguin enclosure intended to prevent a penguin-shaped ice cube from melting under a heat lamp. The penguin shaped ice cube simulates the melting of the ice caps where penguins dwell. Groups are given a limited amount of play money to purchase materials to use for construction of the dwelling. The materials available vary in their capacity to insulate and reflect heat, and youth may experiment with them to determine the best materials to use for their dwellings. Through an iterative process, youth are guided to correct errors and improve earlier iterations of dwelling designs.

3.3 Text and video data collection

Throughout the Studio STEM programme, facilitators and youth were encouraged to interact through the social networking site Edmodo. The project manager of Studio STEM and the site leader within the school system administered and maintained the Edmodo site. Youth were added to the group, making automatic friend connections among several school sites where Studio STEM was hosted. This prompted them to engage with each other without having to accept each request, laying the groundwork to initiate a conversation among youth from different schools.

Transcripts of facilitator and youth discourse through Edmodo over the course of six weeks were analysed. Special attention was given to the type of discourse relative to the HOMAGO framework of media engagement (Ito et al., 2010). Youth were given time during most Studio STEM sessions to sign in to Edmodo and engage with the technology. While on Edmodo, facilitators would encourage discussion related to Studio STEM by posting related prompts. At the end of each week, a graduate doctoral student at the local university was responsible for processing data from Edmodo. Textual data collection was limited to discourse from the Edmodo site. All postings were read and analysed thoroughly.

Video was chosen as a secondary method of data collection. Video data captures not only the talk of the youth, facilitators, and site leaders, but also the tone of voice, facial expressions, and interactions with materials (Derry et al., 2010). Two undergraduate researchers used mini, handheld video cameras to record the talk and interactions of two small groups. The youth were broken up into six small groups of 5–6 students. Each undergraduate researcher focused on collecting data for one small group. Transcripts of the video recordings were analysed in order to compare patterns of engagement within Studio STEM with patterns of engagement on the Edmodo site.

3.4 Discursive psychology

Discourse analysis involves the study of how people communicate, and how that communication leads to action (Potter, 2003). The communication analysed can be either in-person dialogue, or back and forth through text-based channels such as instant messaging clients or social network sites. Discursive psychology is a field that utilises discourse analysis to examine language and how people ascribe meaning to that language. Language is situational (appears within a context), action oriented (utilised to achieve an objective), and constructive, as if is made up of much smaller components (Roth, 2008). Work by Lester (2011) also suggests that qualitative research on discourse may also provide insight into cognition and understanding. Discourse between youth and instructors about STEM concepts could therefore provide clues about the way that a subject is perceived and understood. Communication through social media such as blogs and wikis serves as an indicator of student feelings of self-efficacy when used as part of a course. Undergraduate students were found to use language indicative of level of self-efficacy and identity throughout a course on human nutrition (Lester and Paulus, 2011). This is not only an important source of feedback for the instructor about student feelings during the course, but can also indicate whether a student will struggle or perform well. Student identity, for example, whether they perceive themselves as being capable or incapable of learning difficult scientific concepts, can affect the way that that student will perform in the classroom. The idea of powerlessness may manifest itself through decreased feelings of self-efficacy, or through a perception of not being in control of the learning environment. For example, students in a formal classroom setting may not feel comfortable articulating their thoughts or questions (Lerman, 2001). Situations such as this can be investigated through the use of discursive psychology methods, and the analysis of student language as a way to gauge their attitudes and understanding (Hsu and Roth, 2012).

3.5 Data analysis

Analysis of discourse conducted through Edmodo was performed using a codebook developed by the research team (Table 1). The codebook was derived from the HOMAGO model to categorise youth and facilitator discourse for further analysis, and the third iteration of the codebook became the working version. Development of the codebook emphasised the action-oriented nature of language (Roth, 2008) in which discourse is undertaken to serve a particular purpose. Here, analysis of language through Edmodo was based on an attempt to understand the purpose behind youth posting as it related to Studio STEM. For example, youth may post for the purpose of increasing social interaction with peers involved in the programme. They may also post for the purpose of asking questions or clarifying concepts discussed in the STEM curriculum. The analytical posture compels one not to assume the talk is merely the reproduction of a priori constructs in the head. Meaning is made through active engagement with peers through the social networking site.

The template for the codebook design was derived from previous work by Evans and Motto (2012). Major code categories included *hanging out*, messing around, and *geeking out* as well as a fourth category of facilitator interaction called *facilitation strategy*. Subcodes were developed to more specifically identify working quotes from Edmodo within each category. For example, a subcode included within the *hanging out* category was *casual social exchange*, which is a code for youth sharing information unrelated to Studio STEM through links, videos, and images. The *hanging out category* was meant to encompass discourse unrelated to Studio STEM, and of a social nature. The *messing around* category was meant to include discourse involved with experimentation and trial and error styles of interaction within Studio STEM. The *geeking out* category was meant to capture discourse that was directed specifically towards knowledge of Studio STEM curriculum and concepts. Finally, the category of *facilitation strategy* was developed to characterise they ways in which facilitators might encourage youth engagement with Edmodo. Subcodes for this particular category ranged from casual facilitation to more formal, directed questions about youth knowledge and experience. Testing for the codebook was performed using the Edmodo transcripts from a previous iteration of Save the Penguins. Subcodes that were included in the original iteration of the codebook were excluded in some instances based upon this test. For example, a subcode entitled *social agenda* was excluded due to the non-existence of discourse falling into that subcode. As the Studio STEM programme progressed, a log was kept in order to organise analysed data from Edmodo transcripts. The log included the coded quotation, participant name, and date of the post. Quotations were not corrected for grammar, punctuation, or spelling, and were logged as they appeared on the Edmodo site's normal feed. Edmodo data were analysed and cross-checked with video transcription data to gauge if there were similarities or differences between participant styles of engagement.

Table 1 Codebook used to analyse Edmodo transcripts

Type of code	*Code*	*Definition of code*	*Example*
Hanging out	Shared interests	Student presents general information about outside interests minimally or unrelated to Studio STEM.	"I like pizza. Do you?" "Who likes Pirates of the Carribean?"
	Virtual co-presence	Student expresses general information about status, location, or activities.	"I'm bored." "Going to the mall!"
	Casual social exchange	Student shares information that they find interesting with peers through the use of links, video or picture files, etc.	"Check out this new movie trailer!" "Cute picture or a puppy!"
Messing around	Looking around	Student shares information from outside sources (example would be Google or Wikipedia) that is related to the STEM programme.	"I found this video about oil spills on Google!" "I saw some cute penguins on Animal Planet!"
	Experimentation	Student expresses that they are going through a process of trial and error. They may ask for assistance with the technology or simply state that they will be making changes to their designs.	"I finally figured out how to use Edmodo!" "I think that my penguin house is too small." "Not saving too many seabird eggs today."
	Team rallying	Student engages in team directed discourse. The aim is to motivate the team to perform better on the project, or to exchange ideas related to the project.	"Team Penguin did so well today!" "I have some ideas! Everyone listen!"
Geeking out	Method comparison	Student displays understanding of, or seeks to understand why their method of design produces different results from another team.	"How did you guys get your penguin to survive?" "How many legos did you use to build your solar car?"
	STEM talk	Student discusses core concepts related to STEM using the vocabulary provided	"Photons make the electrons in the solar car move." "I think that the penguin house conducted too much heat."
	Directed inquiry	Student asks specific questions related to Studio STEM content	"Can someone tell me what insulation is?" "Was current or the voltage the thing that mattered most?"

Table 1 Codebook used to analyse Edmodo transcripts (continued)

Type of code	*Code*	*Definition of code*	*Example*
Facilitation strategy	Casual facilitation	Facilitator initiates conversation through the introduction of questions or content minimally or unrelated to Studio STEM.	"Did everyone have a good weekend?" "I think penguins are cute too!"
	Task orientation	Facilitator asks questions about Studio STEM content or directs youth to the task at hand.	"I think it's great that you like pizza, but who can tell me about motors?" "Does anyone else have a question about insulation?"
	Assessment	Facilitator inquires about student feelings towards the programme and/or what youth have learned.	"How did everyone feel about STEM today?" "Who can tell me what we learned about heat transfer?"

Video was analysed and coded and used as a secondary source of data. Upon completing class recordings, video talk and actions were transcribed. Transcriptions were coded and analysed for sequences of talk and non-verbal gesture demonstrating student interaction with the curriculum. Atlas ti© was used for thematic coding and analysis.

4 Results

4.1 Do youth come to change understandings of science through Studio STEM, particularly through interactions via social media?

Youth did utilise the Edmodo technology as a forum for learning about and discussing scientific concepts. However, from the postings on Edmodo used as the corpus for this investigation, there appears to be no linear progression of youth through the HOMAGO model, which is not unexpected. Youth do not progress from *hanging out* postings to *messing around* postings, and then to *geeking out* postings in stage-like fashion. Instead, the posts are mixed in terms of category, and youth may jump between categories at any point. This mirrors the pattern of the video transcripts, in which participants naturally move between on-task and off-task conversations. However, the video transcript data show more movement between the *messing around* and *geeking out* categories than the *hanging out* category, perhaps due to the nature of the time points for video data collection. Neither dataset necessarily contradicts the descriptive theories of Ito et al. (2010) since there is no specification that HOMAGO involves a progression from one category of engagement to another. Despite the frequent category jumping observed, youth did demonstrate understanding of science concepts more accurately, and in greater detail at the end of the programme compared with the start of the programme. This was evidenced by the use of scientific language within posts related to Studio STEM. Youth also participated in question and answer style posts both with one another and with facilitators as a way of demonstrating new content knowledge and clarifying concepts.

4.2 Do interactions through social media depict changes in understanding?

A total of 640 posts in 199 conversations were created during the course of the Studio STEM programme according to data from external evaluators. The distribution of posts by topic is depicted in Table 2. All code categories and subcodes were used during the course of the study, verifying the effectiveness of the codebook (see Appendix). There was a natural progression observed in youth postings related to the point at which the Save the Penguins curriculum had reached. For example, the first day of the programme was dedicated to setting up Edmodo accounts and completing a pre-test to assess prior knowledge of heat transfer concepts. Youth were not given instruction on any of the materials related to the course, and as a result, the vast majority of posts were coded into the *hanging out* category. An example would be a post such as, 'is anyone having a good time..... anyone?' coded into the *virtual co-presence* subcode on the first day of the programme. This post was not followed by a response. In contrast, on the first penguin house construction day, youth were prompted with a question and were able to respond with more posts that were coded into the *geeking out* category. An example here would be a post such as, 'Ours bc we put an insulator inside', which was a *STEM talk* coded post in response to the question, 'Who thinks their house is going to be the best at 'saving the penguin?' Why??? The participant uses the word 'insulator' in order to provide a reason for the potential success of their design. This is most likely a result of youth possessing more background knowledge (provided through the Powerpoint lecture and hands on experiments) at this point in the Studio STEM curriculum. The use of scientific language was common in posts, and indicated increases in youth understanding and vocabulary.

Table 2 Distribution of Edmodo posts by topic

Category of post	*Percentage*
Stem content	23%
Social posts	32%
House design	22%
Programme evaluation	23%

4.3 What forms of engagement occur through social media during Studio STEM?

The vast majority of the Edmodo posts were created and made available to the group during the designated internet time built into the Studio STEM sessions. On days when there was not enough time available for Edmodo, very few posts were created. This was true regardless of online prompting by facilitators through the posting of questions, and regardless of face-to-face encouragement at the end of the Studio STEM session. In this way, discourse in Edmodo was very much situated and driven by context. Without designated Edmodo time, youth did not appear to be motivated to engage with the Edmodo technology from home. Edmodo appeared to be under utilised at times due to access. A site leader commented that the computer lab was not easily accessible and a separate space from where the Studio STEM was being run stating, "But, for us, the technology part is so separate because we need to go to the computer lab to go on the computers." While some youth did attempt to engage with the technology outside of the classroom as evidenced by posts such as, 'Is anybody on at this time?' posts outside of Studio STEM rarely ever received responses in real-time. Still, a lack of Edmodo posts from outside of the Studio STEM environment does not necessarily mean that there was a lack of understanding or engagement with science concepts. While youth may not have been engaged with Edmodo outside of the learning environment, they appeared actively engaged with the technology when they were given time to do so. An example can be found in the following discourse. All responses were completed on the same day as the first prompting question:

[1] T.D. to Save the Penguins: Why do you think your penguin ice cube melted the way it did under the lights? What will you do differently in the re-build?

[2] B.F. – we are going to put white felt around it and some cotton balls

[3] S.S. – um......probably put more Myler or more light colored material or alum. Foil

[4] B.R. – The Arctic Power Pengiuns are going i think we have not talk about it but i think that we are going to more bubble wrap in side of the house and out side

[3] S.S. – good idea B.R.

[4] B.R. – I agree with your group S.S., our group is going to put myler and some more bubble wrap.

Posts such as, 'I cannot wait to next week' pulled from the beginning of the programme and, 'I had fun at STEM, anybody else agree?' pulled from the end of the programme are indicative of youth interest and perception of the Studio STEM experience overall. The vast majority of posts used positive language to describe youth experience within the Studio STEM programme. Positive language was interpreted as an indication that youth remained engaged with the curriculum, and enjoyment of the experience.

One particular factor that seemed to affect the type of postings by youth was whether a facilitation strategy was used. Youth had a greater frequency of postings within the *hanging out* category when the research team and site leaders did not direct them towards a particular topic. Here, a participant engages in discourse for the purpose of *hanging out*:

[1] A.R. to Save the Penguins: if you love stem reply me back!!!♥♥♥♥♥

[2] F.F. – Hey

[3] H.L. – tap me

[4] S.S. – meee!!!!

[5] V.N. – STEM peeps in da house

Discourse such as this has no purpose other than to interact casually with other participants. When facilitators asked questions directly related to the material ('What materials will you use to re-design your house?'), youth were much more likely to respond with postings that could be categorised as *messing around* or *geeking out*. This is not to say that youth did not engage in STEM talk without facilitation, but just that the frequency of STEM talk, whether accurate or indicative of misconception, was much higher with prompting. A good example would be this particular collection of posts:

[1] T.D. to Save the Penguins: which material was a better insulator and why?

[2] G.D. – Wool, because it keeps the warm air out!

[3] H.L. – wool, it was very thick to keep the cold in and the heat out.

[4] F.F. – Wool i cant rember why

[5] B.H. – it was the wool sock because it was filled in air and the heat couln't move inside to make the soda cold

[6] A.S – it was the wool sock because it was the best isalator and kept the cool in better

[7] S.S. – wool because it had a good amount of air in the sock for it to be a good insulator.

From this example, it is apparent that facilitation results in responses by participants. This is consistent with Kolodner et al. (2003) demonstrating that engagement of youth with new material is somewhat dependent upon engagement of facilitators. Though this sample was taken from earlier on in the Studio STEM curriculum (misconceptions such as the ability of coldness to transfer are still common), youth are seen to begin to understand and articulate concepts such as insulation and the ability of heat to transfer.

Prompting can be a powerful tool for informal learning environments such as Studio STEM. Prompting in the form of productive questioning has also been found to contribute directly to articulation of understanding versus misunderstanding, an important step in challenging misconceptions (Chin and Osbourne, 2010). Given the correct prompts, youth might remain focused and on task, but also know they have the freedom to say 'hello' and see if their peer group is also online and active (Ito et al., 2010). Youth often use social media to develop friendships, and they will do this with acquaintances, such as other participants within Studio STEM.

5 Discussion

5.1 Studio STEM influences youth understanding of science concepts

In response to the first research question, analyses indicate that Studio STEM had an effect on youth understanding of heat transfer concepts. Responses by youth often included scientific terminology introduced through the STEM curriculum, and were often accurate. There were also a larger number of posts related directly to STEM material once participants had undergone the lecture on heat transfer and engineering. Posts prior to the experimentation and house construction programme sessions were unrelated to the curriculum, and were created for the purpose of socialisation. This suggests that involvement with Studio STEM increases youth knowledge and interest in heat transfer concepts and application resulting in more science-related discussion.

Our results are consistent with previous literature highlighting the effectiveness of informal extracurricular science programmes in promoting science understanding among middle school aged youth (Sadler et al., 2000; Cantrell et al., 2006; Rogge, 2010; Wals and Corcoran, 2012). Previous research has shown that the presence of well-defined goals helps to engage youth interest and interaction with science challenges (Sadler et al., 2000). Studio STEM also provides a well-defined goal (to Save the Penguins through constructing an enclosure), and appears to have a positive impact upon participant knowledge and interest in science. While misconceptions were still evident at points throughout the programme, this possibly was a result of individual participant variation, and not of the way in which the programme was implemented. For example, the idea of heat as something that moves, and cold as something that does not move escaped several youth despite exposure to the concept throughout the programme. Other youth were able to pick up on this concept from the first presentation on heat transfer. Engagement with, and interest in the material was strong throughout the programme as indicated through positive posts to the Edmodo website.

5.2 Youth remain engaged with Studio STEM through social media

Youth engagement through social media was conceptualised using a framework of discursive psychology, making the use of language highly important. Engagement and interest appeared to be concurrent throughout the Studio STEM programme. Posts including language describing Studio STEM activities and material in a positive light were common among participants. Positive posts between participants were also common, particularly when there was a discovery of shared interests. Posts expressing negative feelings towards Studio STEM, other participants, or the presence of a goal were very uncommon. When they did occur, language was used to express feelings of confusion about the activity for the next session, or disappointment about the performance of penguin house iterations. The rarity of language portraying negativity indicates that youth retained a positive impression of Studio STEM throughout the duration of the programme, and that they were interested and engaged with the curriculum.

Today's youth may be engaged in multiple contexts for communication, friendships, and play through their engagement with social media (Ito et al., 2010). In fact, previous work shows that youth interaction through social networking increases feelings of belongingness, particularly in boys (Quinn and Oldmeadow, 2012). While youth engagement may be situated and driven by prompts from the site leaders and project manager, the underlying practices of sociability and learning are also present when using the HOMAGO model.

5.3 Social media are useful in capturing youth understanding

Use of Edmodo as a source of data was effective in capturing youth interest and understanding during the Studio STEM sessions. The ability of social networking sites to maintain a permanent record of discourse in real-time makes data highly accessible to the research team. The main difficulty associated with the use of Edmodo as a data collection tool was time for youth to interact with the technology. Depending on the session, participants may not have had time specifically devoted to Edmodo due to the need to complete other activities. This resulted in low posting frequency with, or without facilitation. With facilitation and adequate time for youth interaction, social media can be a useful way to assess youth understanding of concepts.

Previous work has suggested that discourse analysis paired with an understanding of cognitive psychology may provide an effective way to generate and capture data (Lester, 2011). The analysis of communication via social media relies on the analysis of discourse through posts online, and can provide information about youth perceptions and articulations of Studio STEM material. When youth and facilitators interact consistently with Edmodo, it becomes apparent whether concepts of heat transfer have been understood. It is also easy to see where misconceptions may occur and whether further explanation is required. Learning environments facilitating peer interaction potentially support learners to share different perspectives on a problem, justify their perspectives, and arrive at a common perspective through negotiation (Harasim, 1990; Scardamalia and Bereiter, 1996). Youth appear willing and able to articulate what they have learned when provided with a prompt and time to respond, consistent with previous work (Hung et al., 2012). The added sense of control that they may have over their learning environment within Edmodo may also contribute to whether youth choose to display their knowledge (Lerman, 2001). While they may not choose to spontaneously discuss Studio STEM concepts without prompting, their understanding may still be altered as a result of the programme.

6 Implications

The assertions derived from this study indicate that Studio STEM likely influenced youth understanding of science concepts, and that this understanding can be assessed through tracking discourse through social media. The use of social media in research may extend informal learning settings and allow for data collection when participants are not physically present in a learning environment. For example, the usage and involvement of library settings for engaging youth with technology has been proposed as a way to facilitate STEM learning away from the classroom environment (Subramaniam et al., 2012). Still, it is necessary to ensure that youth have enough time and motivation to interact with the social media technology. Further research should address the factors influencing the use of social media by youth outside of the learning environment. By examining comparable qualitative studies across a range of populations and social media practices, further research could also inform informal STEM researchers on how social media practices are embedded in a broader social and cultural ecology for youth in informal learning environments. As Rhodes (2004) has noted, after school experiences are a critical aspect of engaging youth in STEM. A goal of Studio STEM, thus, was to expand the opportunities for interaction, exchange, and caring by providing an online platform, Edmodo, familiar to youth and their undergraduate mentors. Though the idea of youth identity in relation to future career path was not examined in this study, it may be interesting to examine whether Studio STEM influences youth identification and interest in STEM related careers in the future. This is particularly interesting as a result of studies indicating that facilitation by professionals in STEM fields is highly influential in female youth perception of STEM related careers (Koch et al., 2010).

There was a high frequency of jumping between engagement styles within HOMAGO. Youth were expected to engage in discourse across all three major categories, but to gravitate more frequently towards the *geeking out* side of the spectrum with the progression of Studio STEM, and increasing exposure to experimentation methods and heat transfer concepts. This shift would be facilitated by the input and encouragement of site leaders and other facilitators including undergraduate and graduate students involved with the project. Instead, it was observed that youth may create posts coded as *geeking out* on one day, *hanging out* on another, and back to *messing around* a few hours later. This was dependent upon the amount of prompting that youth received from facilitators. Since there was no limit imposed upon the amount of posting a participant could do, participants were often involved in multiple threads. Thread topics varied resulting in a participant for example, answering a facilitator's question about heat transfer in one thread, and going back to talking about a favourite sports team in another. Results imply that the model is not, and perhaps were not meant to be viewed as a linear progression, but rather as a set of descriptions for three different ways in which youth engage with technology. Further work is needed to determine how youth understanding of science changes as a result of participation in, and engagement with Studio STEM. The recent work of Ito et al. (2013) on connected learning may provide a framework for further understanding the gap between knowledge acquired through Studio STEM and application of knowledge in the real world. The integration and maintenance of youth science understanding remains an important aspect of Studio STEM, and deserves further examination.

7 Conclusions

Participants in the Studio STEM engaged with Edmodo in all three formats described by Ito et al. (2010). Nevertheless, there was no observed progression of engagement styles a long a fixed trajectory from hanging out to messing around to geeking out. This suggests that the HOMAGO model, while applicable and relevant, should not be conceptualised as a linear model. The amount of time and facilitation that participants received to interact with Edmodo was more indicative of engagement style than the time point within the programme (early vs. middle vs. late). Engagement was very much situated as a result.

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Appendix

Hanging out

Posts by youth that were coded into the hanging out category were unrelated or minimally related to Studio STEM material. Hanging out posts were created for the purpose of casual interaction between participants. Examples included sharing interests, links to media related to interests, and informing other participants of status.

[1] S.S. to Save the Penguins: why did you pick this topic?

[2] G.D. – I don't get what you mean, S.S.

[3] F.F. – Because they are endangered

[4] H.L. – What topic?

[5] M.C. – Because their cute

[2] G.D. – CUTE!!!!!!!!!!!!!!!!!!!!!!! XD

In this example, S.S. asks a question in regards to the motivation of other Studio STEM participants in joining the programme. Others respond with general reasons, or ask for clarification, but there is no actual purpose besides learning about one another and perhaps forming friendships. The conversation continues for several posts, but there is no discussion of STEM concepts. A second example of a hanging out coded conversation would be the following:

[1] A.S. to Save the Penguins: I wish I could own a penguin C.L. u need to get on edmodo

[2] C.L. – I HERE!!!!!!

[3] K.G. – wobble wobble

[4] F.F. – me to

In this example, A.S. is hoping to interact with C.L. who announces that she is available to chat. Other participants then insert non-sense type responses and announce their own presence. This conversation was created in order to provide information about participants' current status. Again, there was no discussion of Studio STEM material presented.

Messing around

The messing around category includes posts that are intermediately focused on STEM material. Oftentimes, they include conversations about trial and error during the experimentation phase of the programme. At this point, while discourse may be focused on process or rallying team members to perform well on tasks, there is no clear cut demonstration of knowledge in STEM material. The following example includes discourse in the messing around category:

[1] T.D. to Save the Penguins: What materials will you use to re-design your house?

[2] B.F. – white felt and cotton balls

[3] S.S. – MYLER,ALUM. FOIL,LIGHT STUFF

[4] B.R. – more bubble is the bestest thing we need

[3] S.S. – watch your grammar B.

[4] B.R. – opps more bubble wrap

[5] F.F. – Same thing as S.S. myler, alum. foil, lightstuff

The facilitator initiates this conversation with a question prompt on the methods used by the Studio STEM participants. The responses would be coded into the messing around category since the purpose of the youth discourse is to compare designs and see what may or may not work for an effective penguin house. While various building materials were mentioned, there was no specific reasoning offered for the choices. It is also important to note that there is a brief lapse from messing around to hanging out in which one participant feels the need to correct another's grammar. This correction was not related to the original prompting question. However, changes between types of engagement such as that seen above, were common throughout the Edmodo postings.

Geeking out

Geeking out posts were directly related to Studio STEM material, and were demonstrative of youth conceptions and understanding. Posts in this category included more complex reasoning and discussion behind material choices for the construction phase of the programme. These posts were often found in response to prompting by the facilitator in the form of questions. They also included direct questions by participants in relation to concepts.

[1] T.D. to Save the Penguins: which material was a better insulator and why?

[2] G.D. – Wool, because it keeps the warm air out!

[3] H.L. – wool,it was very thick to keep the cold in and the heat out.

[4] F.F. – Wool i cant rember why

[5] B.H. – it was the wool sock because it was filled in air and the heat couln't move inside to make the soda cold

[6] A.S. – it was the wool sock because it was the best isalator and kept the cool in better

[7] S.S. – wool because it had a good amount of air in the sock for it to be a good insulator

The example above is a good example of geeking out. A facilitator provides a question, and youth are motivated to answer the question with the answers that they believe to be correct. Many of the posts created provided reasoning for why the participants believed wool to be a better insulator. Whether the youth conceptions were accurate or not, there was conscious effort involved in using new vocabulary (insulator) and to grasp the ways in which heat acts (movement). Youth are articulating their understanding of distinctly STEM related material through their discourse.