Enacting the teacher-parent-learner nexus in teaching and learning science using technology

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Abstract
The teaching and learning of science have far-reaching curricular objectives which require teachers, students, and parents to be engaged in the teacher-parent-learner (TPL) nexus. During this endeavour, learners are guided to relate their prior knowledge to the science concepts (Grade 9, age group 13-14 years) during a home task activity under the supervision of their parents through an initial collaborative engagement (ICE) on the myptim platform (www.myptim.org). After finishing this activity, learners are invited to submit their work on the platform following their parents’ confirmation through the parent’s platform. In this paper, through an exploratory multiple case study involving six students and four parents, we present preliminary findings regarding the use of the myptim platform for the study of a lesson on ‘Measurement’. The empirical evidence collected through unstructured interviews with the participants indicates that the myptim platform is a promising technological pedagogical tool for the advancement of the teaching and learning of science, in particular, physics. This paper contributes to literature on technology integration through the perspective of teacher-parent-learner nexus.

Keywords: teacher-parent-learner nexus, technology, myptim platform, prior knowledge, science

Introduction
In this study, we expound a discussion on sustaining the learning of science, in particular, physics, by students using technology while adopting the pedagogical technological integration framework (Ramma, Bholoa, Watts & Nadal, 2018) which encompasses a novel technology-based approach, the teacher-parent-learner (TPL) nexus. The principal research question guiding the conceptualisation of this paper is: How can technology be used to create an interactive setting for enacting the TPL nexus for conducive teaching, support, and learning by teachers, parents, and learners? In this paper, we preferred to use the terminology ‘learner’ rather than ‘student’ for “if educators view students as children, they are likely to see both the family and the community as partners with the school in children’s education and development” (Epstein et al., 2002, p. 20).

It is often taken for granted that the use of technology in education can “enhance learning” (Kirkwood & Price, 2013, p. 7; Nikolopoulos & Gialamas, 2018). A variety of research studies have demonstrated the benefits of technology in education (Ghavifekr & Rosdy, 2015; Dias & Victor, 2017; Ramma, Bholoa, Watts, & Nadal, 2018) - as well as its drawbacks, in particular when it is not fully integrated in teachers’ practices (Pedro, Piedade, Matos, & Pedro, 2019).

Säljö (2010, p. 54) is of the view that “digital curriculum materials and multimedia resources have not been able to assert themselves as part of regular educational practices to the extent that some predicted they would”. This view is not an isolated one but rather, one that is shared by several researchers who believe that attention should be given to the further alignment of teaching, learning, and assessment (Brown, 2009). We certainly believe that technology in teaching and learning has the potential for transforming education as teachers are nowadays more familiar with technology (Mueller et al., 2008). However, in our view, technology integration in teaching and learning demands a paradigm shift from the traditional approach to a technological pedagogical approach, where learners develop core competencies and skills (de Koster, Volman & Kuiper, 2017) for real life problem-solving by interacting with digital artifacts. Learning with technology can certainly extend students’ learning both in and outside formal learning environments (Lillejord, Børte, Neste, & Ruud, 2018) – more certainly where carefully crafted lessons incorporate formative and diagnostic assessments, which form part of a holistic teaching-learning-assessment strategy, mediated by technology-based scaffolding (Zydney & Warner, 2016).

Pellegrino (2005, p. e7) offers an interesting argument that posits “… assessments do not offer a direct pipeline into a student’s mind” as the assessment attributes related to “… mental representations and processes … are not outwardly visible”. Assessment incorporates a social dimension (Deane, 2011) as well as contextual components (National Research Council, 2001) and, in order to capture dimensions other than cognitive skills, having recourse to technology can simplify matters by capturing data quietly, in a most unobtrusive manner, ‘behind-the-scenes’ (Rupp & Leighton, 2016, p. 2). Thus, the use of technology can render assessment a simplistic task, especially when learners are engaged in a contextual problem-solving activity.

Arguably in this 21st century, the purpose of education - driven massively by technology - is to promote success in work, citizenship, and life in its entirety. In order to create interest in students to learn and practise science, this implies that “… classroom learning experiences in science need to connect with the own interests and experiences” (National Research Council, 2012, p. 28) and that prior knowledge should be at the base of the knowledge
construction process (Limon, 2001). Connecting learners’ classroom experiences with out-of-school experiences in interactive problems (Tsankov, 2018; Trolian & Jach, 2020; Darling-Hammond et al., 2020) is a challenging task for teachers, but we are persuaded that this approach will benefit both the teachers and students in the long run, not least because the construction of purposeful scientific knowledge in students has a long-term effect for developing creativity in the latter (Roberts, 2004). The consideration of the parent factor in the education of the learner is unequivocally a significant element in the teacher-learner technology equation.

The Teacher-Parent-Learner Nexus

In this study, the focal point of our attention is to situate how learners, using technology in various forms - mobile phones, tablets, laptops, or personal computers, can relate their prior knowledge of a given concept, say, measurement (which is learned at Grade 9 – age 13-14 years) with a given minds-on (or hands-on) home task in their informal out-of-school environment (Ramma et al. 2021). The role of parents is not to demonstrate adequate “cognitive bandwidth” (Barrera-Osorio. et al., 2021, p. 10) of a science concept, but to assist and support their children while they are engaged in doing a home task through the technology medium - the myptim platform. The support could be in the form of ensuring that appropriate logistics (internet connection, materials - for this pilot study - a ruler, measuring tape, etc) are available. Furthermore, we have considered Grade 9 as research has constantly been raising awareness that parental support is most impactful across elementary middle and high school years (e.g. Simon, 2004) and students feel cared for and work to achieve their full potential in learning (Epstein et al., 2002).

This project, the first of its kind in Mauritius, intends to showcase the school-home partnership through the TPL nexus (Figure 1) within initial collaborative engagement (ICE).

The home task acts as driver for initiating learning in a systematic way outside the school premises and it also offers possibilities to revamp and reshape traditional pedagogy. The adoption of technology-based inquiry activities supports and enhances interaction and collaboration among parents, teachers, and learners in a socio-constructivist set-up (Williams, Nguyen, & Mangan, 2017). The collaboration between teacher-parent, parent-learner, and teacher-learner is collegial and conversational (Bilton, Jackson & Hymer, 2017) and represented by the non-delineated intersection area in Figure 1.

Initial Collaborative Engagement (ICE)

ICE captures three dimensions within the Collaborative Engagement Experience-based Learning (CEEBL) - behavioral engagement, cognitive engagement, and affective engagement (Frey, Sedaghatjou, Rodney, 2021). Table 1 offers an insight into the three dimensions, integrated within the TPL nexus, thus forming the ICE.
Table 1: ICE

<table>
<thead>
<tr>
<th>Types of Engagement</th>
<th>Teacher-Parent Nexus</th>
<th>Parent-Learner Nexus</th>
<th>Teacher-Learner Nexus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioural</td>
<td>• Inform about learning activity on myptim</td>
<td>• Ensure functionality of internet connection.</td>
<td>• Activate prior knowledge of learners on myptim platform</td>
</tr>
<tr>
<td></td>
<td>• Communicate learner effort towards learning process through myptim</td>
<td>• Identify a designated area at home for online learning.</td>
<td>• Plan for the use of appropriate teaching-learning resources in incoming lesson</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Make provision for concrete resources</td>
<td></td>
</tr>
<tr>
<td>Cognitive</td>
<td></td>
<td></td>
<td>• Testing of prior knowledge</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Develop factual, conceptual, and procedural knowledge</td>
</tr>
<tr>
<td>Affective</td>
<td>• Facilitate continuity (Pirchio et al., 2013)</td>
<td>• Show interest in children learning</td>
<td>• Work collaboratively towards creation of knowledge</td>
</tr>
<tr>
<td></td>
<td>• Enable trust building</td>
<td>• Enable open door communication</td>
<td>• Respect of views – agree to disagree</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Maintain discipline</td>
</tr>
</tbody>
</table>

Figures 3-6 offer a salient insight into the mechanism of the three types of engagement for the teacher-parent-learner nexus.

Architecture of the myptim platform

Through ICE, the science teacher initiates a preliminary discussion for learners to relate their prior knowledge to the science concepts (Grade 9, age group 13-14 yrs) at home with parents as support through the myptim platform (www.myptim.org). Figure 2 illustrates the architecture of the myptim platform, which hosts the three subject areas (biology, chemistry, and physics) and shows the interconnectedness among the three stakeholders.

![Figure 2: myptim architecture](image-url)
Figure 3: Teacher Platform - TP Nexus

Figure 4: Teacher Platform – PT Nexus
The *myptim* platform acts as an interactive medium and creates a nexus between the science teacher and parents to initiate a conversation about the type of support that parents need to offer when their kids are doing an assigned science home task. This teacher-parent interaction is carefully mediated by the teacher as the “knowledge bases of parents and teachers are also fundamentally different” (Vedeler, 2021, 14). The students’ platform contains the science lessons which include (i) testing of prior knowledge in the form of home tasks, (ii) introduction of the concept, coupled with a set of diagnostic assessments tasks, (iii) hands-on and minds-on activities linked with
formative assessments, (iv) summative assessments, and (v) a real-life scenario on critical thinking related to the concept in focus. The information collected on the myptim platform is analysed by the teacher with a view to adopting appropriate differentiated pedagogical interventions to meet the learning needs of the three categories of learners (low, average and high ability). The myptim platform also becomes a medium for follow-up activities for subsequent lessons imitates the flipped classroom model for teaching and learning, where the teacher-parent-student nexus adds a new dimension to that model.

The Study

To validate the myptim platform (structure of the platform and content) as well as the conception of the PTL nexus, a pilot study was conducted with five students and four parents. We report using an exploratory multiple case study within a qualitative approach to generate findings from nine independent interviews with the students and their parents. The necessary gatekeeper access was sought, and approval was received from authorities prior to implementation the pilot study. Parents offered their consent by filling a form for themselves and their children. The interviews were conducted by the researchers by phone.

A deductive approach was adopted for the analysis of the interview responses from both parents and learners. The deductive codes emanating from the associated guiding questions (Stuckey, 2015) for the interviews are illustrated in Table 2.

Table 2: Interview Questions

<table>
<thead>
<tr>
<th>Codes</th>
<th>Learner Interview Questions</th>
<th>Parent Interview Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myptim infrastructure</td>
<td>How do you find the myptim platform?</td>
<td>How can we improve the myptim platform for better conversations?</td>
</tr>
<tr>
<td></td>
<td>What are the features that you like on the myptim platform?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>How can we improve the myptim platform?</td>
<td></td>
</tr>
<tr>
<td>Teaching and learning</td>
<td>Would like the platform to be used as a teaching and learning resource?</td>
<td>What did you observe when your child was doing the task on the platform?</td>
</tr>
<tr>
<td></td>
<td>What is the added value that the platform offers as compared to traditional teaching-learning?</td>
<td></td>
</tr>
<tr>
<td>Parental engagement</td>
<td>How do you feel when your parent is involved in this type of learning process?</td>
<td>How far do you find the myptim as an opportunity to engage in a discussion with your child?</td>
</tr>
</tbody>
</table>

Findings

Myptim Infrastructure: Learners

All the six students found the platform to be “user friendly”, “very helpful”, “easy to use” and “easy to access”. For instance, one of the students reported that

*S4*: *The platform is very easy to log in since it’s quite simple and it’s not bulky, so it’s easy to find the things and to click on and find the lessons. ... because it has a clean interface, the lessons were easy to follow”.

Student S5 found the platform to be “useful and helpful” as there were different activities focused on a particular concept, which helped her develop a better understanding of the concept.

In relation to the features related to the platform, all the students were appreciative of the quizzes and the video to illustrate the concept, for instance S1 stated that:

*S1*: *... the materials have been presented in a well-structured manner. The videos incorporated in the lessons were also very interesting.*

One student [S3] summarized the features of myptim as follows:
S3: Prior knowledge enables a link to be made with what I knew. Instant feedback is laudable. Quizzes are interesting. Videos are useful. Materials are relevant.

A prominent feature for improving the architecture of the platform, as reported by all the students, was the inclusion of structured questions, similar to those found in the prescribed physics textbook. On probing further, the researchers found out that the traditional approach to learning was still prevalent as the students were trying to make adjustments to their learning repertoires to accommodate this novel approach to learning, which was caused by a cognitive conflictual situation pertaining to the customary approach to teaching and learning and beliefs (Kang, Scharmann, Kang, Noh, 2010).

Myptim Infrastructure: Parents

All the parents found the platform to be a medium whereby they could be involved in the education of their children. One of the parents highlighted:

P1: I was already involved in the learning process of my child. But still, I see this myptim website has helped me to better engaged with my child’s learning process.

Another parent [P3] indicated that the instructions set on the platform were not bulky and could be accessed anytime to check for updates from the teacher [researcher].

Teaching and Learning: Learners

All the students claimed that the platform was a valuable learning resource as it extended their knowledge base. Student [S3] viewed the lesson on the platform as a useful “supplement to school lectures”. He clarified that “some materials [videos, pictures] are not available in classes” for discussion.

One of the students, Student [S5] stated that:

[S5]: With the website, the students will get the correct answers and the teacher can do other things.

This idea put forward by the student indicated a strong potential of the myptim platform to promote differentiated instruction. Furthermore, student S2 offered some evidence that the platform could be used for providing timely and appropriate feedback. He added that the platform encouraged him to become autonomous and more motivated to learn:

[S2]: I will be less dependent on my teacher. The quizzer activities motivate us to learn.

Student S3’s response also supported the argument for autonomous learning in the following manner:

[S3]: We can continue our learning if ever the teacher is absent in the class.

Though there was general agreement that this platform could enhance the teaching and learning of physics and spur a paradigm shift at school, one of the students [S5] cast doubt as to whether the platform would be integrated and effectively used by the class teacher.

[S5]: I don’t think the teacher may find it helpful.

Parental Engagement: Learners and Parents

Most students acknowledged the proximity of engagement of their parents while they were doing the home tasks on the myptim platform:

[S1]: Feels good and encouraging. Parents can keep track and monitor our learning in a systematic way.
[S2]: I am happy, my parent is engaged in my learning process. My parent is monitoring my learning. It is a much better compared to school.

However, some students displayed mixed feelings regarding parental engagement, like student [S6], while others, for example. student [S5], were not supportive of the idea of working in the presence of their parents.

[S5]: I feel awkward. I do not like it when they see that I have obtained a wrong answer. They will scold at me. I want only when I have got all the correct answers and then I can show it to them.

[S6]: Yes, I like to do my exercises in front them. But I don’t like when they scold me. Only when I am struggling, and I ask them for help.

Interestingly, all the four parents interviewed expressed their appreciation to be offered the opportunity to be engaged in providing support to their children in their learning.

[P1]: I was already involved in the learning process of my child. But still, I see that this PTIM website has helped me to better engage with my child’s learning process.

One parent pointed out that this approach to her engagement with her child on the platform had enable her to “…learning new things and I can ask them [my children] if I don’t understand myself”.

Discussion & Conclusion

The findings clearly corroborate with Lillejord et al. (2018) that technology can extend students’ learning outside the formal learning environment, mediated by parental engagement (Epstein et al., 2002). The myptim framework facilitates the parent-teacher-learner nexus and further aligns learning with real-time feedback from diagnostic and formative assessments, thereby incorporating the social dimension (Deane, 2011) to develop knowledge, understanding, and higher order thinking. From the findings, it is inferred that learners may not be fully ready to use technology for their day-to-day lessons as they have not experienced this kind of learning culture at school. They also fear that their teachers might not employ the platform effectively to enhance the teaching and learning of physics. In line with de Koster et al. (2017), the integration of the myptim platform requires teachers to have a paradigm shift from their traditional didactic approach to a technological pedagogical approach to teaching and learning while collaborating with parents. In turn, parents should be made aware that they are equal partners with schools in the education of their children and consequently, they must contribute to set up a conducive environment at home for learning within the affective dimension.

The design and development of the myptim platform is an iterative process and requires regular periodic reviews to cater for the needs of learners, teachers, and parents to cement the dynamic nature of the TPL nexus and transcend from the ICE to a prolonged and sustainable collaborative engagement.

Acknowledgement

This paper forms part of a research project on the teaching and learning of science using technology, funded by the Higher Education Commission, Mauritius [Grant TEC/11/4/13/17]. The authors also acknowledge the preliminary discussion they had with D. Authelsen on the aesthetic elements of the platform.
References


