Enhancing student learning by combining Problem Based Learning and Human Patient Simulation

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**Abstract**

Problem-based learning (PBL) and Human Patient Simulation (HPS) are two teaching modalities that actively involve and engage students in their learning. PBL and HPS are utilised in Undergraduate Medical Education in the UK, to assist in the development and training of medical students, yet they are frequently used as separate entities in the learning process. Learning is enhanced when students are provided with the opportunity to apply their theoretical learning into a real life context. HPS provides the opportunity for the practical application of theoretical knowledge. By merging the two teaching modalities together, it reinforces existing knowledge gained from PBL. A small-scale, mix-methods, research study was conducted to assess undergraduate students’ learning experience from combined PBL and HPS.

**Keywords:** Undergraduate medical education; Problem based learning; Human Patient Simulation

**Introduction**

Problem-based learning (PBL) and Human Patient Simulation (HPS) are two teaching modalities that actively involve and engage students in their learning. Both use case-based learning scenarios for teaching, but the application of learning from these teaching modalities varies greatly. In PBL, cases are discussed within a group setting, developing students’ theoretical knowledge. HPS provides an opportunity for a case to become as life-like as possible, and students have to recognise and treat medical conditions appropriately. PBL and HPS are utilised in Undergraduate Medical Education in the UK, to assist in the development and training of medical students, yet they are frequently used as separate entities in the learning process.

Learning is enhanced when students are provided with the opportunity to apply their theoretical learning into a real life context (Liaw, Chen, Klainin, Brammer et al., 2010). HPS provides the opportunity for the practical application of this theoretical knowledge (Weller, 2010). By merging the two teaching modalities together, it reinforces existing knowledge gained from PBL (Murphy, Hartigan, Walshe, Flynn et al., 2010). HPS has the additional learning
advantages of allowing students to develop non-clinical skills, such as team working, leadership and communication skills, during the educational process.

A small-scale, mix-methods research study, was conducted at Royal Preston Hospital, to assess students’ learning experience from combined PBL and HPS. The students were Fourth Year Medical Students, from the University of Manchester Medical School. Students’ theoretical learning, clinical application of this knowledge and non-clinical skills from the combined PBL-HPS teaching was evaluated, to assess whether these combined pedagogies enhance their undergraduate learning.

Method

The paediatric unit at Royal Preston Hospital had an existing in-situ high fidelity simulation mannequin, which could be utilised for this study, without causing conflict with existing timetables and allowed PBL-HPS sessions to occur in concordance with the PBL schedule. Therefore, the students on their fourth year paediatric undergraduate rotation were suitable candidates for the study. Ethical approval was sought from the hospital trust and deemed not required, as no patients were involved in the process. Permission was also granted from the Hospital Dean for Undergraduate Medical Education at Royal Preston Hospital, to ensure the study would not conflict or hinder the students training.

The eight-week paediatric placement was the first exposure to paediatrics for the students in their training. During this period, they had six PBL scenarios. These scenarios were reviewed to assess whether they were adaptable to PBL-HPS scenarios. Three of the six scenarios were suitable: neonatal shock, bronchiolitis and febrile convulsion.

The PBL cases had pre-written intended learning outcomes. The PBL-HPS scenarios were mapped to these learning outcomes, to ensure students learning needs continued to be met and developed appropriate to their stage in training. Additional learning objectives for the HPS were:

- ABCDE (airway, breathing, circulation, disability, exposure) assessment and management of an unwell infant;
- Communicating with a parent during an emergency situation;
- Obtaining a relevant history from a parent under time constraints;
- Handover of the patient to a senior colleague;
- Development of non-technical skills, including team-working, leadership and situational awareness.

The study was run for two consecutive paediatric rotations. All students in these rotations were invited to participate by email. It was not compulsory, as it was an optional addition to their normal PBL, and no student was adversely affected if they decided not to participate.

Data collection

Turning-Point software was used to collect quantitative data pre and post each PBL-HPS session. These were multiple-choice questions, in which the students had to rate their own abilities in assessing and managing acutely unwell infants, as well as their non-technical skills. An example of these questions are displayed in Table 1.

Focus groups were held which each of the four groups, at the end of their rotation, which were recorded and transcribed. The transcripts were thematically analysed to identify themes from the data (Braun and Clarke, 2006).
The students opened a PBL case as normal, creating their intended learning outcomes as a group. In the subsequent week, the students did their own private studying for the case. As part of the closing the case, the students first had a relevant simulated scenario, in which they encountered a high-fidelity simulated unwell infant and a simulated parent (actor). The simulated parent increased the fidelity of the scenario, as a parent is present in the majority of paediatric emergency situations and their needs need to be met too.

Prior to HPS, the students designated roles within their group:

- One student was to obtain a history from the simulated parent and relayed relevant information to the group.
- Two students were to observe and give feedback. They were encouraged to identify clinical and non-clinical skills demonstrated.
- The remainder of the group was to assess and manage the unwell infant, and designate roles such as scribe and team-leader as they deemed appropriate.

Clinically, the students were expected to perform an ABCDE assessment on an acutely unwell infant, respond appropriately to findings and initiate management. They were guided through the emergency calculations for the infant, based on the infant’s age or weight, at the beginning of the scenario. The students were encouraged to request investigations as part of their management, and handover the patient to a senior colleague at the end. The scenarios were designed to reflect real-life clinical situations.

The debrief following the Simulation allowed the students the opportunity to reflect on the scenario, discussing their management of the simulated infant, areas they struggled with and aspects they managed well. A PBL facilitator was present to guide the discussions. This enabled the students to continue to self-direct their own learning needs, similar to normal PBL session. The debrief session progressed into the continuation of the closing of the PBL case, to ensure all the intended learning outcomes from the case were addressed.

Table 1: Turning-Point questions for Bronchiolitis scenario

| Pre and Post-Simulation questions |
|----------------------------------|
| • How confident are you at completing an ABCDE assessment on an acutely unwell infant? |
| • How confident are you at managing an acutely unwell infant with symptoms of respiratory distress? |
| • How do you rate your ability in requesting appropriate investigations for an acutely unwell infant? |
| • How do you rate your ability to formulate an appropriate differential diagnoses for an infant with acute respiratory distress? |
| • Do you feel comfortable talking to a child’s parents and providing appropriate reassurance whilst their child is acutely unwell? |
| • How do you rate your professional non-clinical skills (team working, communication, leadership etc.)? |

Results

All students from the two rotations agreed to participate. In total, there were 32 participants: each rotation contained 2 groups of eight students, and each group performed all three PBL-HPS scenarios. Twelve PBL-HPS sessions were conducted, with every scenario being run four times. Due to other commitments and the PBL-HPS sessions being optional, there was not a 100% attendance of all the students every week. This created variation in the numbers of students displayed each session in the Turning-Point results.

Data from Turning-Point collected students responses to each PBL-HPS session, as well as track whether their answers to each question changed with the repeated PBL-HPS sessions. Diagram 1 displays students Turning-Point response pre and post PBL-HPS sessions, on their ability to perform an ABCDE assessment on an unwell infant, for
each of the three scenarios. The pre and post PBL-HPS responses to each of the three scenarios (febrile convulsion, neonatal shock and bronchiolitis), are depicted in graphs in Diagrams 2-4. Diagram 5 shows the students’ responses to communicating with the simulated parent and diagram 6 depicts their perceived ability at non-clinical skills after each PBL-HPS session.

Diagram 1: Confidence at completing an ABCDE assessment

Diagram 2: Febrile Convulsion scenario feedback

Diagram 2a
How confident are you at managing a neonate or child with a seizure?

Diagram 2b

How do you rate your ability in requesting appropriate investigations for a neonate or child with a seizure?

Diagram 3: Neonatal shock scenario feedback
Diagram 3a
How confident are you at managing an acutely unwell and shocked neonate?

**Pre-SIM**

**Post-SIM**

How do you rate your ability in requesting appropriate investigations for an acutely unwell neonate?

**Pre-SIM**

**Post-SIM**

Diagram 3b

How do you rate your ability to formulate an appropriate differential diagnoses for an acutely unwell and shocked neonate?

**Pre-SIM**

**Post-SIM**

Diagram 4: Bronchiolitis scenario feedback

Diagram 4a
How confident are you at managing an acutely unwell infant with symptoms of respiratory distress?

Diagram 4b

How do you rate your ability in requesting appropriate investigations for an acutely unwell infant?

Diagram 5: Communication skills feedback from Turning-Point
Diagram 6: Feedback on development of non-clinical skills
Focus group feedback

Has PBL-HPS enhanced your learning from PBL and, if so, why?
Students reported that PBL-HPS combined consolidated their learning from PBL. The scenarios were realistic and relevant to their learning, and they found it beneficial to put their knowledge into practice. It improved their recall and understanding on the topic to a greater extent than is possible in PBL. Simulating how a condition presented helped with learning the signs and symptoms of conditions. Students described that learning the theory is different to remembering how to manage conditions in a clinical context, and that reading and understanding the management does not reflect whether they can actually manage the condition clinically. They would not have realised this, at this stage in their training, without the combined sessions.

The students found HPS useful in identifying gaps in their knowledge, which could previously be hidden in PBL sessions from reading their notes or being quieter during discussions. Likewise, students recognised the combined sessions encouraged them to learn their PBL learning objectives more thoroughly, to assist them during the simulation. This is in comparison to PBL sessions, where it would not always be apparent that they not had learnt their work. The students felt that they had learnt more through PBL-HPS than they did through normal PBL sessions.

PBL can become tedious, especially with the whole group having similar sources for the discussions, and the
students found the PBL-HPS sessions reignited their enthusiasm and motivation to learn and removed some of the monotony of PBL. They described PBL-HPS making their learning more diverse and interesting.

**Has PBL-HPS helped with your clinical work?**
Students reported that the systematic approach of ABCDE assessment, used repeatedly in HPS, improved their confidence at managing an acutely unwell infant or adult in an emergency situation. In addition, it gave them more confidence in clinical environments and decreased their apprehension at approaching unwell patients.

The scenarios encouraged students to consider differential diagnoses and subsequently their capability at formulating differentials when reviewing patients on the Paediatric Assessment Unit improved. It helped re-iterate the seriousness of medical conditions, for example, bronchiolitis can be life-threatening, but can easily be overlooked when there are multiple milder cases of infants with bronchiolitis on the ward.

Examining an unwell infant in HPS taught the students the importance of thorough examinations in infants, including checking for rashes, capillary refill, femoral pulses, the fontanelle and remembering to cover a baby again after exposing them during the examination. It also boosted their confidence in handling and examining infants. HPS provided the opportunity to practice clinical skills, such as cannulating and giving intravenous fluids. These are skills they would not normally have the opportunity to learn during paediatric placements.

**Has PBL-HPS helped develop your professional and non-technical skills?**
The students described that PBL-HPS assisted them in developing team working skills, and the importance of allocating roles within the team, such as team-leader and scribe. It helped them recognise whether they naturally become team-leaders or followers in emergency situations.

It taught them other aspects of team working, such as good communication, including not talking over one another and re-iterating vital information during emergencies. Additional non-technical skills gained from the PBL-HPS sessions were situational awareness, the importance of documentation and learning how to prioritise tasks in pressurised situations. These were skills viewed as important by the participants and would not have had the opportunity to develop them in normal PBL sessions. They described noticing a progressive improvement in their non-technical skills throughout the period of the combined PBL-HPS sessions.

The students disclosed, in clinical settings, they are normally spectators of emergency situations and are not encouraged to participate. Through PBL-HPS, the students felt they had clinical opportunities that they may not have experienced until becoming qualified doctors.

**Has the Simulated parent present during the scenario been beneficial?**
The simulated parent was useful and realistic for the students. The PBL-HPS scenarios allowed students to practice taking a focused history. Communicating with a parent in an emergency and obtaining a history under time constraints, was a new experience for the students. Students found it challenging to gain the balance between obtaining a history and updating and reassuring the parent regarding the baby’s progress. Participants described this as useful and important communication skills to learn. It was likely to be one of the few opportunities they will receive at practicing communicating with parents in emergencies until they have to do it in a real situation.

**Discussion**
The combined PBL-HPS sessions were well received by students. Feedback demonstrated the sessions positively contributed to the students learning, improving their theoretical knowledge, clinical skills and development of non-
technical skills. Learning is enhanced when learners can perceive the meaning and intrinsic relevance of the subject matter to their own purpose (Liaw et al., 2010). This is not always immediately identifiable in PBL, but can become more apparent through simulated clinical scenarios (Weller, Robinson, Larsen & Caldwell, 2004). PBL-HPS provides a clinical context and relevance to the students’ theoretical learning. It aids the learning process, as well as bringing an extra dynamic to the PBL discussions (Liaw et al., 2010). If students can visibly see they are learning and it appears relevant to them, their enthusiasm and motivation to learn increases (Fanning & Gaba, 2007).

The findings from this study are supported by previous small-scale studies, exploring the benefits of combined PBL and HPS for medical or nursing education (Liaw et al., 2010; Wimmer, Wilks, Grammer, Doerr et al., 2014; Winston & Szarek, 2005). Although the population groups in these studies varied from this one (for example, nursing students or pre-clinical medical students), our study re-enforces and contributes to existing knowledge on the topic, establishing that the combined PBL and HPS are beneficial to students’ medical education.

Winston & Szarek (2005), combined PBL with HPS for American medical students in their pre-clinical years, and identified HPS gave context to the students’ theoretical learning. Our study supports this conclusion and demonstrates that combined PBL and HPS continues to provide clinical context to students’ theoretical knowledge, during their clinical years of medical school. Participants in our study, Winston & Szarek (2005) and Wimmer et al (2014) all described that PBL-HPS highlighted gaps in their knowledge base, that were not always apparent in PBL.

HPS allowed students to acquire clinical skills, demonstrate medical management and opportunities not possible through PBL discussions (Sohn, Ahn, Lee, Park et al., 2013). Discussing the medical management of a condition differs from demonstrating this knowledge. HPS or combined PBL-HPS has been shown to be more effective than PBL for acquiring acute management and assessment skills (Liaw et al., 2010; Steadman, Coates, Huang, Matevosian et al., 2006). The repetitiveness of HPS can also aid student acquisition of skills and knowledge (Liaw et al., 2010). Participants in our study noted their clinical confidence increasing due to the frequency and repetitiveness of the PBL-HPS sessions.

PBL-HPS allowed social and psychological components of health to be demonstrated in greater context. The role-play within simulation increased students’ exposure to these areas. For example, one PBL scenario had a life-threateningly unwell infant; mother with limited English and previous sibling die in infancy. Reading and discussing this scenario was not as effective as attempting to take a history from a distraught mother with limited English. This PBL-HPS encouraged the students to consider beyond the clinical needs and management of the infant, such as the psychological impact on the mother.

Non-technical skills, such as leadership, team-working and decision-making are additional learning benefits from HPS (Wimmer et al., 2014). A theoretical understanding of non-technical skills is less beneficial than practical opportunities to appreciate the importance of such skills (Wimmer et al., 2014). The students from our study demonstrated an increased awareness and understanding of non-technical skills through repeated PBL-HPS.

Wimmer et al (2014), similarly, found introducing HPS to first year medical students provided the students with a better understanding and working knowledge of non-technical skills at a much earlier stage in their career. An earlier understanding of these skills will benefit the students in their future careers.

Integrating PBL with HPS encouraged students’ to study, improved their knowledge and helped identify knowledge gaps. It provided them with the opportunity to become confident with their clinical skills and familiar with a structured approach for recognising and managing an acutely unwell patient. The students gained extra insight into the psychological and social aspects of health, through the role-play in HPS. In addition, the combined sessions have assisted in the development of their professional skills. These finding consistently reflect that combined PBL-HPS...
enhances the students learning experience.

**Conclusion**

This small-scale combined PBL-HPS study demonstrated that HPS was a positive addition to PBL. It encouraged the students to learn, reinforced knowledge, allowed clinical exposure and developed students’ confidence. It enabled students to gain extra skills and knowledge that would not have occurred from PBL sessions alone. The combining of these teaching modalities has improved the medical education the students receive. This consequently will improve their abilities as future clinicians and positively impact future patient care.

**Take Home Messages**

- Combining PBL and HPS enhance students learning
- HPS encourages student engagement and motivation to learn
- PBL and HPS help students develop of clinical and non-clinical skills

**Notes On Contributors**

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Jane Crowther is a Paediatric Clinical Skills Facilitator for Undergraduate Medical Students.

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**Appendices**

None.

**Declarations**

*The author has declared that there are no conflicts of interest.*

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**Ethics Statement**

This study was seen as a quality improvement project - improving medical education and only involved undergraduate students and no patients. The study did not meet local criteria to need ethical approval.

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