Facilitating teaching and learning of teratogens: Using alcohol and drug neonate simulators in Further and Higher Education

Short title: Facilitating student learning of teratogens

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Abstract

Drug and alcohol neonate simulators were used to highlight the effects of substance misuse on prenatal development within lifespan development modules to 61 Psychology undergraduates and 12 sixth-form Health and Social Care students. A mixed method approach was used considering both knowledge development and perceptions of experiential hands-on learning. Student knowledge of the effects of drugs and alcohol on prenatal development was assessed before and after an interactive session on teratogenesis utilising neonate simulators demonstrating these effects. With this experiential learning approach, the statistical analysis combining both groups showed increased knowledge after the interactive session, and the students perceived this enhanced understanding to be a direct result of hands-on interaction with the neonate simulators. The researchers encourage the use of neonate simulators as good practice that can be effectively incorporated into the psychology and other health-related teaching contexts to facilitate knowledge on teratogenesis.

1. Introduction

The current British Psychological Society (BPS) core curriculum for an accredited psychology degree programme requires students to cover developmental psychology in order to understand typical and atypical development across the lifespan (BPS, 2019). Within the developmental psychology core curriculum, students study human lifespan development often starting with prenatal development and the effects on the newborn, as biological changes during pregnancy can have an impact on later human behaviour. When studying this topic, students learn about the potential impacts from drugs and alcohol on the foetus and the newborn baby. Traditional methods of teaching, of this and other topics, are often less student-centred as the teacher imparts knowledge to their uninformed students (Friere & Ramos, 1982; Hanschke, 2001) who then do not question or relate what they know to a practical or professional context (Giroux, 1988). Based upon Kolb's (1984) experiential learning theory

and Bloom's (1956) taxonomy of learning, not using a student-centred approach leads to ineffective student knowledge from the taught content as they are not actively engaging and thinking critically about the topic. In contrast, when learning follows a constructionist pedagogy there are opportunities for experiential learning, active experimentation and reflective observation which enable higher-order thinking (Kolb, 1984).

According to the BPS (2019), an accredited psychology programme should be designed to foster critical thinking, for example identifying arguments, evaluating observed evidence, drawing conclusions and reflecting upon issues (Cottrell, 2011). This reflects Kolb's (1984) experiential learning approach as students can reflect on both an academic and personal level in order to enhance their own understanding and active engagement within sessions. This can include a variety of active experimentations to transform their experiences, including peer-to-peer interactions, role play scenarios, and technology enhanced learning such as simulation-based education (SBE). SBE is being endorsed as a new teaching strategy (Andersen et al., 2018) to enhance student engagement and improve knowledge of taught content whilst encouraging active hands-on experimentation and active reflection on the learned experiences (Paranhos & Mendes, 2010; Zigmont et al., 2011). The students are involved in this active reflective cycle (Kolb, 1984) while interacting with the simulator rather than simply listening or reading about the topic. Therefore, the student becomes immersed in a constructionist pedagogy and the learning is grounded as an active methodology.

The use of neonate simulators would therefore make a valuable contribution to the teaching of the lifespan psychology topic of prenatal development and risk-taking behaviour. In adolescence and young adulthood there is an increase in these risk-taking behaviours (Carrasco-Garrido et al., 2018), and many may be unaware of the impact of teratogens. These are substances such as drugs and alcohol that can have a dramatic impact during pregnancy in the intrauterine environment (teratogenesis) at both prenatal, embryonic and postnatal stages (Capra et al., 2013; Nwoke, 2008). Alcohol and drug use combined with casual sexual behaviours can increase the risks of unplanned pregnancies and negative outcomes on the developing foetus (Capra et al., 2013; Johnston et al., 2017;

Nash & Davies, 2017; Salas-Wright et al., 2015). There are a range of associated risks from teratogenesis including miscarriage, Sudden Infant Death Syndrome (SIDS), congenital birth defects, Foetal Alcohol Spectrum Disorders (FASDs) and Neonate Abstinence Syndrome (NAS) (Guerrini et al., 2009; Irner, 2012; Royal College of Obstetricians and Gynaecologists, 2006).

Women who drink alcohol regularly and in large quantities during pregnancy are likely to give birth to offspring suffering from FASDs, the effects of which can range from mild to severe (Blaschke et al., 2009; O'Leary & Bower, 2012). The most identifiable physical features for FASDs include physical facial phenotype malformations (thin upper lip, smooth philtrum and small eye openings), small gestational size and central nervous system malformations (Caputo et al., 2016; Hagan et al., 2016; Williams et al., 2015). In addition to alcohol misuse during pregnancy, research has confirmed that drugs can impact prenatal development. Drugs such as cannabis, marijuana and benzodiazepines affect the baby differently, but most suffer withdrawal symptoms related to Neonate Abstinence Syndrome (NAS), for example uncontrollable tremors (Hulse et al., 2002). Drug-affected babies tend to be smaller in size and have learning and memory abnormalities through childhood (Geng et al., 2018).

In an American-based research study, Boulter (2007) used peer-to-peer teaching around the impact of alcohol and drugs during pregnancy with a large sample of 642 middle school and high school students. This included a video presentation of the effects of alcohol on prenatal development, a multiple-choice test to assess understanding of FASD, and a discussion of both alcohol and drugs as teratogens utilising drug and alcohol neonate simulators. The alcohol neonate simulator illustrated the physical effects of an infant born with FASDs but was low fidelity as it had no interactive qualities. Also shown was a medium-fidelity neonate simulator that not only illustrated appearance, but also demonstrated the shrill cry and tremors of a real drug-affected infant with Neonate Abstinence Syndrome (NAS). The students discussed the physical and behavioural effects that could be observed on both simulators while gaining hands-on experience. The students were then retested at a six-week follow-up to assess retention of knowledge about FASD, although they were not tested on their knowledge of the effects of drugs despite being shown both simulators. Quantitative findings revealed

an increase in knowledge of the effects of alcohol consumption during pregnancy after the video presentation and this further increased after interaction with the neonate simulators (Boulter, 2007). Importantly, the qualitative findings revealed that the students learned that no amount of alcohol is safe during pregnancy, they enhanced their knowledge on the physical, cognitive and behavioural effects of alcohol misuse during pregnancy, appreciated there was no cure for FASDs, and that the impact can be long term (Boulter, 2007).

There is limited use of neonate simulators in UK schools (Hussain et al., 2019) and in undergraduate programmes as a form of facilitative teaching and learning. Symons and Smith (2014) used virtual reality technology (VRT) with 117 second year developmental psychology undergraduates to facilitate their understanding of parenting styles. Through basic quantitative data using rating scales and percentages, they report that the students psychologically engaged with their virtual babies and they enhanced both their learning and critical thinking skills. However, the data was not statistically analysed and the teaching and learning environment lacked kinaesthetic hands-on experience (Julal, 2018). Therefore, Julal (2018) used the fully interactive virtual baby simulator with 288 second year undergraduate students studying the topic of attachment. They were involved in interactive workshops which provided hands-on experience with the simulators which enabled greater understanding of this developmental topic. Similar workshops using drug and alcohol stimulators were used with 50 midwifery undergraduates to demonstrate the impact of problem substance use during pregnancy utilising a qualitative methodology (Khan & Cescutti-Butler, 2021). More research is needed to look at the use of these with psychology undergraduates studying teratogens as part of the BPS accredited degree.

The current research built upon previous studies and employed a single simulation experience with the drug and alcohol neonate simulators used in previous research by Boulter (2007) and Khan & Cescutti-Butler (2021). However, the study involved UK-based further (FE) and higher education (HE) students as the use of neonate simulators is not common practice in UK schools or universities to teach psychological topics. In contrast to Boulter's study, the students were taught and assessed on

the effects of both alcohol and drugs, while Boulter only taught and assessed knowledge of FASD despite allowing the students to interact with both the drug and alcohol simulators. The current study considered whether these neonate simulators could be used to enhance student understanding of teratogenic effects on prenatal development similar to the midwifery study by Khan and Cescutti-Butler (2021). It was therefore hypothesised that the understanding of teratogenic effects would be greater after a workshop incorporating the neonate simulators. While the research question for the qualitative analysis explored how the students perceived the simulators as facilitating their own and others' understanding of teratogenic effects.

2. Method

2.1 Participants

The participants attended a sixth-form UK Academy and a South of England University. The sixth-form sample consisted of twelve Year 13 students studying BTEC Level 3 Diploma and Certificate in Health and Social Care, Unit 1 Human Lifespan Development. They had a mean age of 17 years, of which all were female, and none had children. The university sample were 61 Psychology Level 4 students studying a Psychology Across the Lifespan module, with a mean age of 21 years, most of which were female (87%) and 11% had children. These undergraduate students were given an incentive of participation time. For both groups the teaching and learning sessions covered the teratogenic effects of drugs and alcohol on the foetus and newborn and incorporated the simulators described below to facilitate knowledge and understanding when teaching the lifespan psychology topic of prenatal development.

2.2 Materials

2.2.1 Alcohol and Drug Neonate Simulators

The research project used a medium-fidelity drug neonate simulator and a low-fidelity alcohol neonate simulator (see Figure 1).

Figure 1: *Foetal Alcohol Low-Fidelity Simulator (Left) and the Drug-Affected Medium-Fidelity Simulator (Right)*

These neonate simulators are produced and manufactured by Reality Works in the USA. The low-fidelity alcohol simulator illustrates the typical facial features and bodily deformities of babies showing Foetal Alcohol Syndrome but has no interactive elements. The medium-fidelity drug simulator physically demonstrates a painful facial expression, small gestational size, and is interactive as it emits cries and shaking typically seen in babies showing symptoms of drug withdrawal (NAS). The cry (which is a real recording of a NAS baby's cry) and shaking can be turned on and off from a switch located on the simulator's back.

2.2.2 Baseline and Post-workshop questionnaires

Two versions of the same questionnaire were used to assess baseline and post-workshop knowledge. This questionnaire was developed around the Reality Works curriculum and consisted of twenty questions on the effects of alcohol and eleven on the effects of drugs. There were a range of question types including fixed-choice, true/false and open-ended style questions. They asked about key terminology and facts, how alcohol and drugs reach the developing foetus, and the short-term and long-term impact of prenatal exposure to teratogens. The post-workshop questionnaire had an additional open-ended question asking them to reflect on their interaction with the simulators. The answers to this question provided qualitative data which was analysed using Inductive Thematic Analysis from a realist perspective and coded at the semantic level (Clarke et al., 2015).

2.3 Procedure

Prior to the workshop, students were given the first questionnaire to complete in class to determine their baseline level of understanding of the effects of prenatal exposure to drugs and alcohol. In the workshop the students were taught about the topic of teratogenesis for one hour, followed by a two-hour interactive session with the simulators. Initially the students interacted with the alcohol simulator and were asked to note its physical appearance and to discuss their understanding of the non-visible effects of alcohol on foetal development. The students then discussed the impact of drugs on foetal development while interacting with the drug simulator to facilitate understanding of NAS. They were asked to note the difference in the cry compared to a healthy baby, how the tremors made them feel along with their thoughts of caring for a baby with NAS. Students were then tasked in small

groups to discuss creative ways to use both the simulators to educate others. A few weeks after the workshop, students completed the questionnaire again to reassess their knowledge and to collect the qualitative data on their perceptions of the effectiveness of the simulators as educational aids. The study was initially carried out with the sixth-form sample and then repeated with the larger undergraduate psychology sample.

2.4 Ethical Considerations

The study was carried out in accordance with the British Psychological Society (BPS) Code of Human Research Ethics (BPS 2014) and ethical approval was provided by Solent University Psychology Ethics Committee to include both student groups. Additional permission was granted from the Headmaster of the Academy. Firstly, students were given information about the study and asked to give written consent to participate in the research and to disseminate the findings. Both groups of students were advised that there would be no consequences if they chose not to take part. Confidentiality and anonymity were assured and maintained, they were advised that they could withdraw their consent, and the students were debriefed afterwards. Due to the sensitivity of the topics being discussed, students were advised in advance of what the workshop would involve and could therefore opt out if they felt the topics would cause any distress.

3. Results & Analysis

Both the baseline and post-workshop questionnaires were scored to determine level of knowledge on the effects of both alcohol and drugs on prenatal development. Each participant had a score ranging from 0 to 90 for both baseline and post-workshop knowledge. In addition, open-ended questions within the post-workshop questionnaire allowed for qualitative analysis of students' responses using Thematic Analysis.

3.1 Quantitative findings

As there were only 12 participants in the college sample it was unfortunately not possible to statistically assess similarities and differences between the two groups and therefore the college and

university data were combined for analysis (n = 73). The data was shown to be normally distributed using a Shapiro-Wilk test (W = .98, p = .23) for the baseline data but departed significantly from normality for the post-workshop data (W = .94, p = .003). Therefore, a Wilcoxon Signed Ranks test was carried out to determine if knowledge and understanding differed between the baseline and post-workshop questionnaires. This showed that understanding of the teratogenic effects of alcohol and drugs significantly increased from baseline to post-workshop, showing a moderate effect size, Z = -7.15, p < .001; r = -.59. Table 1 shows the median scores for the whole sample along with the data for each group separately illustrating the increase in knowledge after attendance at the workshop.

Table 1 *Comparison of Baseline and Post-Workshop Median Questionnaire Scores for Knowledge of the Effects of Alcohol and Drugs on Prenatal Development*

Questionnaire Scores	University Sample	College Sample	Combined Sample *
Baseline	40.0	48.5	43.0
Post-workshop	57.0	54.5	57.0

* p < .001

3.2 Qualitative findings

It was important to look at the students' perceptions of the effectiveness of the workshop as the interpretation of the quantitative data was only tentative given that it was difficult to separate the impact of the simulators alone, from the workshop as a whole. Therefore, Inductive Thematic Analysis was carried out on the open-ended responses in the post-workshop questionnaire to a question asking participants to explain why they thought interacting with the simulators would facilitate their understanding of teratogenic effects. This analysis followed the six steps described by Clarke et al. (2015) where the authors independently familiarised themselves with the entire data set and then extracted preliminary codes and generated potential themes. These were then reviewed collaboratively resulting three themes: Physical Experience, Illustrating Real-life, and Issues in Practice,

along with written extracts to illustrate these. It was not possible to carry out member checking as not all students were available to verify their comments once the data was analysed.

3.2.1 Theme 1: Physical Experience

The students commented that having the physical interaction with the simulators highlighted the effects of drugs and alcohol and how serious the outcomes and impact can be. The subtheme of 'Hands-on Experience' related to comments about physically seeing, feeling and hearing these effects. This kinaesthetic interaction allowed students to marry theory with individual handling of both simulators, as well as acknowledge how this aided their understanding of the effects. For example:

> *It was a clear visual aid – the sound from the [drug neonate simulator] doll was alarming – brought the dangers … to life – clear to see the effects. (Undergraduate 1)*

> *It was a really horrible feeling when I held it and heard it cry. It definitely made me more aware. (Undergraduate 2)*

> *You can really see and feel how it effects them. (Sixth-form Student 1)*

The students commented on how 'really horrible' and 'alarming' it was to experience seeing and feeling the simulator and to therefore know what it would be like to hold a baby with NAS who was shaking uncontrollably. Both sixth-form and undergraduate students noted that this hands-on experience would lead to greater awareness of how babies are affected by drugs and alcohol. This was highlighted further in the other subtheme of 'Highlighting Different Outcomes' where many of the students commented on how the simulators clearly illustrated the outcomes. They noted how they could compare the size, weight and stature of the two simulators, and the following student additionally highlighted the differences between these babies and a healthy baby:

> *Seeing the size of [the two] dolls helped me to understand teratogenic effect on prenatal development. They were much smaller than a healthy baby and much lighter. It was a helpful*

thing to see the differences and how using drugs and consuming alcohol can affect the foetus. (Undergraduate 3)

By having the physical experience of holding the two simulators, this student was able to feel the light weight and see the size and could compare this with each other and any experiences they had with healthy babies, again illustrating the impact of drugs and alcohol in extreme doses.

3.2.2 Theme 2: Illustrating Real-life

Many students commented that the addition of the simulators in the classroom helped them fully understand the outcomes for these babies because it provided them with a real-life perspective. This is reflected in the first subtheme of 'Real-life Understanding':

Because the dolls are based on real babies … it showed just how badly it could affect a child. I was particularly shocked with the dolls tremors and cry. (Undergraduate 4)

The student is showing awareness that these simulators illustrated the real-life outcomes and how shocking it was to experience what NAS would feel like and to listen to the real recording of the baby's cry. In addition, the following three students noted how these real-life, hands-on, first-hand experiences enhanced their understanding:

It helped to really understand as you saw first hand and it's hard hitting. (Sixth-form Student 2)

Because it gave me a real life object to link the understanding and info to. (Undergraduate 5)

Linking hands-on practical experience is important to complementing learning and in depth understanding. (Undergraduate 6)

All three of these students from both sixth form and undergraduate psychology were aware of how this 'hands-on', 'hard-hitting' interaction with the simulators helped their understanding by giving them a 'real life object' that they could relate the material to. This complementary nature of the lecture material and the simulators was further illustrated in the subtheme of 'Better than a Traditional Lecture'. Many students noted that this real-life experience enhanced their understanding

more so than just sitting in a lecture and listening to a description of the effects or being shown pictures or a video as part of the presentation. For example:

> *Gave a visual, hands-on experience on how drugs and alcohol can affect prenatal development. Far better than simply pictures on a slide. (Undergraduate 7)*

This student commented that the addition of the simulators made the experience more 'hands-on' illustrated the effects on the babies much more so than if they had had a traditional lecture where pictures were shown on slides. Other students agreed that this was better than looking at pictures or reading about the information in textbooks. Similarly, the following sixth-form student wrote:

> *It made it more real and more eye opening, but also show the effects better than any video. (Sixth-form Student 3)*

This student felt that even if they had watched a video illustrating the effects it would not have been as good as the hands-on experience the simulators provided. Finally, the following student acknowledged that even though these were simulators, they still had an impact:

> *Because it puts it into perspective … rather than just talking about it, you see it, even if it isn't 100% real it still leaves a mark and has an impact. (Undergraduate 8)*

While simulators are not 100% real, they still have the power to 'leave a mark' on those who interact with them leading to a lasting impact on their understanding. The subtheme of 'Memory Aid to Complement Learning' also illustrated the long-term impact by noting how the students saw the simulators as adding not only to their understanding but also their memory processes. For example:

> *They were scary so I'll remember them. (Undergraduate 9)*

Like the quotes from undergraduates 1, 2 and 4, this student noted their reaction to the simulators. The fact that they scared them seemed to make them believe that this would result in long-term

retention of the experience and therefore they would remember the information about teratogenesis that the simulators illustrated.

3.2.2 Theme 3: Issues in Practice

Long-term impact of the simulators was a common theme that emerged, with students noting their personal learning and that the increase in awareness of teratogenesis would have an impact in terms of future development for them personally and for others. In the subtheme of 'Self', a few students were able to relate their understanding from the taught session and interaction with the simulators to themselves. For example:

> *If I would try to get pregnant in the future I will not drink any alcohol and be really careful when it comes to this. (Undergraduate 10)*

The simulators are designed as a teaching aid and this student showed awareness that this training would make a difference to how they would behave in the future. In addition, in the subtheme of 'Others', some students commented on how the simulators would be beneficial in influencing others' behaviour:

> *Flash of reality – people can brush words and warning off easily, but up-close experience can change their view. (Undergraduate 11)*

The student felt that personal interaction with the simulators could change the way other people would view prenatal drinking and drug-taking. They saw this experience as a 'flash of reality' that would be a more powerful educational tool than any traditional warning of the adverse outcomes of these risk-taking behaviours during pregnancy.

4. Discussion

The current study was based on Boulter's (2007) American-based research and assessed the knowledge and understanding on teratogenesis of sixth-form Health and Social Care and undergraduate Psychology students before and after interaction with neonate simulators designed to

facilitate teaching and learning. The quantitative findings confirmed the hypothesis as there was a significant increase in knowledge acquisition and retention after the workshop where they had the opportunity to interact with the simulators. Both cohorts of students could more easily identify and report the symptoms and impact of alcohol and drugs on development therefore increasing their questionnaire scores between baseline and post-workshop testing. The current research therefore supported Boulter's (2007) study who also reported enhanced knowledge on the impact of alcohol on the foetus after interaction with the neonate simulators. These quantitative findings of increased knowledge were further enhanced by the qualitative responses. Both cohorts of students similarly noted how the physical interaction helped them to easily identify and understand the impact on foetal development. Like Boulter's (2007) participants, the students could see the physical facial features of the alcohol-affected simulator, as well as feel and hear the withdrawal symptoms from the constant shaking and shrill cry of the drug-affected neonate simulator. In addition, they could compare the size and weight of the two simulators resulting in comments around the differences between each of them and compared with typically developing babies.

The simulators provided a real-life, hard-hitting illustration that led to an immersive experience in the reality of the impact of teratogens. Both cohorts saw that the simulators not only complemented traditional teaching and learning methods but extended their knowledge and understanding around the long-term impact, as they commented that they would be able to remember these effects in the future. Several of Julal's (2018) students similarly commented that the interactive workshop helped them clarify their understanding of the concepts being taught and the experience made the information more memorable than just reading about the effects. In addition, both Julal (2018) and Symons and Smith (2014) similarly found that the use of simulators (whether neonate simulators or a VRT programme respectively) improved psychological engagement and critical thinking.

The students felt confident enough with their newly developed knowledge on teratogenesis to think critically about how this might impact their own behavioural decisions in the future, as well as more broadly in terms of educating others. However, the long-term impact was not measured, as the

current study did not directly assess student risk-taking behaviour change over time. Even so the students found the interaction with the simulators beneficial, memorable and impactful. Julal's (2018) students similarly commented on how enjoyable, memorable, different and exciting the workshop sessions were. The students in the current study showed an enhanced appreciation of the need for education about risk-taking behaviours which is important given the increase in such behaviours in adolescence and young adulthood (Carrasco-Garrido et al., 2018). They felt that engagement with the simulators would help change views about drinking and drug-taking during pregnancy, more so than just providing traditional warnings of the effects. These current findings therefore supported Julal's (2018) and Symons and Smith's (2014) research where simulators were successfully embedded into the psychology teaching environment and provides further endorsement of the use of these neonate simulators to facilitate teaching psychological concepts. The current study concentrated on neonate simulators to enhance understanding of prenatal development, but it could also relate to the teaching of addiction and its impact on the family within the adulthood period of lifespan development. In addition, the use of other virtual baby simulators can also facilitate the teaching of other developmental topics like attachment and parenting which are often covered on lifespan developmental modules on BPS accredited programmes. Future research could widen the use of neonate simulators to the teaching and learning environment of these other psychological topics, and to interdisciplinary research looking at other health-care programmes like midwifery (Khan & Cescutti-Butler, 2021), nursing and social work.

Student interaction with the neonate simulators enabled them to be immersed in the reality of the short and long-term impact of teratogens on development. This hands-on interaction, along with the directed activities within the taught session, allowed students to go through Kolb's (1984) experiential learning cycle combining psychomotor, cognitive and affective domains. The concrete interactive experience with the simulators enabled them to use reflective observation, to integrate this with their previous knowledge and to think critically about the impact of drugs and alcohol on foetal development. At the end of the taught session, the students felt confident enough with their

knowledge on teratogenesis to consider the real-world implications for their own future behaviour and that of others, as they critically discussed and showed awareness of the need to educate others about risk-taking behaviours. Students from different health-related backgrounds and educational levels, such as Psychology and Health and Social Care, benefitted from using the neonate simulators and were therefore able to relate theory into practice and their learning was grounded in an active experiential methodology.

It is important to note that a control group was not used in this research as it would have been unfair and unethical to randomly allocate the student participants to a control or experimental group as the topic was being assessed with both groups, especially given the aim of the study to enhance the students' learning. The college students had exam questions covering the topic of teratogenesis and prenatal development and similarly the university students had an assessed essay question on the topic. The quantitative findings are therefore tentative as it was not possible to determine if the simulators alone led to the increase in knowledge scores or the teaching material. Boulter (2007) similarly did not use a control group, and their procedure tested knowledge after a video presentation and then again after an interactive session with the simulators. Knowledge was shown to increase further after that interaction. In addition, Julal's (2018) students reported that interaction with the simulator was the most useful activity for developing their understanding. Similarly, the current qualitative findings clearly illustrated how the students across both groups believed that the addition of the simulators into the teaching and learning session led to enhanced understanding and impact, more so than just having a presentation, video or discussion around the topic. However, there were a few limitations with the data as the small sample of sixth-form students did not allow for statistical comparison and the open-ended question which provided the qualitative data was leading as it directly referred to the simulators. It would have been beneficial to rephrase this question to ask the students for feedback on the workshop in general without specific mention of the simulators. In addition, member checking should have been carried out to verify the qualitative findings. Future research will therefore ensure that these points are taken into account.

In conclusion, the findings suggest that drug and alcohol neonate simulators can be successfully embedded into an interactive teaching and learning environment. Many of the students from both cohorts clearly found the hands-on interaction with the neonate simulators aided their knowledge and understanding of the impact of teratogenesis on prenatal development within their lifespan psychology sessions. Despite this being a single simulation experience the students believed it was effective for developing their understanding and higher-order thinking about risk-taking behaviour.

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References

Andersen, P., Baron, S., Bassett, J., Govind, N., Hayes, C., Lapkin, S., … Simes, T. (2018). Snapshots of simulation: Innovative strategies used by international educators to enhance simulation learning experiences for health care students. *Clinical Simulation in Nursing*, *16*, 8-14. doi: https://doi.org/10.1016/j.ecns.2017.10.001

Blaschke, K., Maltaverne, M., & Struck, J. (2009). *Fetal alcohol spectrum disorders education strategies: Working with students with a fetal alcohol spectrum disorder in the education system*. Sioux Falls, SD: Center for Disabilities, Sanford School of Medicine of The University of South Dakota.

Bloom, B. S. (1956). *Taxonomy of educational objectives. Vol. 1: Cognitive domain.* McKay.

Boulter, L. T. (2007). The effectiveness of peer-led FAS/FAE prevention presentations in middle and high schools. *Journal of Alcohol and Drug Education, 51,* 7-26.

British Psychological Society (2014). *British Psychological Society code of human research ethics.* British Psychological Society.

British Psychological Society (2019). *Standards for the accreditation of undergraduate, conversion and integrated Masters programmes in psychology.* British Psychological Society.

Capra, L., Tezza, G., Mazzei, F., & Boner, A. L. (2013). The origins of health and disease: The influence of maternal diseases and lifestyle during gestation. *Italian Journal of Pediatrics, 39*, 7. https://doi.org/10.1186%2F1824-7288-39-7

Caputo, C., Wood, E., & Jabbour, L. (2016). Impact of fetal alcohol exposure on body systems: A systematic review. *Birth Defects Research Part C: Embryo Today: Reviews*. https://doi.org/10.1002/bdrc.21129

Carrasco-Garrido, P., Jimenez-Tujillo, I., Hernandez-Barrera, V., Garcia-Gomez-Heras, S., Alonso-Fernandez, A. A., & Palacios-Cena, D. (2018). Trends in the misuse of tranquilizers, sedatives and sleeping pills by adolescents in Spain, 2004-2014. *Journal of Adolescent Health, 83*, 709-716. https://doi.org/10.1016/j.jadohealth.2018.04.003

Clarke, V., Braun, V., & Hayfield, N. (2015). Thematic Analysis. In J. A. Smith (Ed.), *Qualitative Psychology: A practical guide to research methods* (pp. 22-248). Sage.

Cottrell, S. (2011). *Critical thinking skills: Developing effective analysis and argument* (2nd ed.). Palgrave MacMillan.

Freire, P., & Ramos, M. B. (1982). *Pedagogy of the oppressed.* Continuum.

Geng, F., Salmeron, B. J., Ross, T. J., Black, M. M., & Riggins, T. (2018). Long-term effects of prenatal drug exposure on the neural correlates of memory at encoding and retrieval. *Neurotoxicology and Teratology, 65,* 70-77. https://doi.org/10.1016%2Fj.ntt.2017.10.008

Giroux, H. A. (1988). *Teachers as intellectuals: Toward a critical pedagogy of learning.* Bergin & Garvey Publishers.

Guerrini, I., Jackson, S., & Keaney, F. (2009). Pregnancy and alcohol misuse. *British Medical Journal, 338*, 829-832. https://doi.org/10.1136/bmj.b845

Hagan, J. F., Balachova, T., Bertrand, J., Chasnoff, I., Dang, E., Fernandez-Baca, D., … Zubler, J. (2016). Neurobehavioral disorder associated with prenatal alcohol exposure. *American Academy of Pediatrics, 138*(4). https://doi.org/10.1542/peds.2015-1553

Hanschke, J. B. (2001). *Putting critical theory into practice through action research* [Doctoral dissertation, Georgia Southern University]. Legacy ETDs 178. https://digitalcommons.georgiasouthern.edu/etd_legacy/178

Hulse, G. K., O'Neill, G., Pereira, C., & Brewer, C. (2002). Obstetric and neonatal outcomes associated with maternal naltrexone exposure. *Australian and New Zealand Journal of Obstetrics and Gynaecology, 41*, 424-428. https://doi.org/10.1111/j.1479-828X.2001.tb01322.x

Hussain, H., Jomeen, J., Hayter, M., & Tweheyo, R. (2019). Implications for school nurses using simulator dolls to manage unplanned teen pregnancy. *British Journal of School Nursing, 14*, 177-188. https://doi.org/10.12968/bjsn.2019.14.4.177

Irner, T. B. (2012). Substance exposure in utero and developmental consequences in adolescence: A systematic review. *Child Neuropsychology, 18*, 521-549. https://doi.org/10.1080/09297049.2011.628309

Johnston, L. D., O'Malley, P. M., Miech, R. A., Bachman, J. G., & Schulenberg, J. E. (2017). Monitoring the future national survey results on drug use: Overview, key findings on adolescent drug use. Ann Arbor, MI: Institute for Social Research, University of Michigan.

Julal, F. S. (2018). Holding the baby: Using the Leiden Infant Simulator Sensitivity Assessment to examine attachment theory's sensitivity hypothesis. *Psychology Learning & Teaching*, *17*, 229-241. https://doi.org/10.1177/1475725718766280

Khan, H. & Cescutti-Butler, L. (2021). Enhancing undergraduate midwifery: Using drug and alcohol baby simulators in education. *British Journal of Midwifery, 29*(11), 620-627. https://doi.org/10.12968/bjom.2021.29.11.620

Kolb, D. A. (1984). *Experiential Learning: Experience as the source of learning and development.* Prentice Hall.

Nash, A., & Davies, L. (2017). Fetal Alcohol Spectrum Disorders: What pediatric providers need to know. *Journal of Pediatric Health Care, 31*, 594-606. https://doi.org/10.1016/j.pedhc.2017.04.002

Nwoke, M. B. (2008). *The effects of teratogens on the health of developing human beings*. Paper presented at the 8th Biennial International Conference on Alcohol, Drugs and Society in Africa, Abuja, Nigeria, 23-25 July 2008.

O'Leary, C. M., & Bower, C. (2012). Guidelines for pregnancy: What's an acceptable risk, and how is the evidence (finally) shaping up? *Drug and Alcohol Review, 31*, 170-183. https://doi.org/10.1111/j.1465-3362.2011.00331.x

Paranhos, V. D., & Mendes, M. M. R. (2010). Competency-based curriculum and active methodology: Perceptions of nursing students. *Revista Latino-Americana de Enfermagem, 18*(1), 109-15. https://doi.org/10.1590/S0104-11692010000100017

Royal College of Obstetricians and Gynaecologists. (2006). Alcohol consumption and the outcomes of pregnancy (RCOG Statement No. 5). Retrieved September 28, 2020, from https://www.alcoholpolicy.net/files/RCOG_Alcohol_pregnancy_March_06.pdf.

Salas-Wright, C. P., Vaughn, M. G., Ugalde, J., & Todic, J. (2015). Substance use and teen pregnancy in the United States: Evidence from the NSDUH 2002–2012. *Addictive Behaviors, 45*, 218-225. https://doi.org/10.1016/j.addbeh.2015.01.039

Symons, D. K., & Smith, K. H. (2014). Evidence of psychological engagement when raising a virtual child. *Psychology Learning and Teaching*, *13*, 52-57. https://doi.org/10.2304/plat.2014.13.1.52

Williams, J. F., Smith, V. C., & Committee on Substance Abuse. (2015). Fetal alcohol spectrum disorders. *Pediatrics*, *136*, e1395-e1406. https://doi.org/10.1542/peds.2015-3113

Zigmont, J. J., Kappus, L. J., & Sudikoff, S. N. (2011). Theoretical foundations of learning through simulation. *Seminars in Perinatology*, 35(2), 47-51. http://doi:10.1053/j.semperi.2011.01.002