ARTICLE
Psychoactive Substances Bill and Act of New Zealand: A Chance to Engage Undergraduate Scientists with Society using a Transfer Learning Paradigm

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Our aim was to develop a teaching paradigm that connected undergraduate's neuropharmacological/toxicological knowledge to that of government policy. One goal of undergraduate education should be to help develop scientists that can use their scientific knowledge to critique government policy. There is little research, however, on whether democratization of science occurs: nor how to achieve this. Our work focused on a semi-structured workshop designed around the Psychoactive Substances Bill (PSB). Third year science students were given a questionnaire that was designed to address whether participating in the workshop enhanced their understanding of the PSB and its relationship to their established knowledge (i.e., transfer learning). Furthermore, whether they felt that they had enough expertise to consider making a submission (i.e., societal engagement). Results showed that the students appreciated the opportunity to explore potential application of their knowledge and delve into a socio-scientific issue. However, our findings suggested they felt uncomfortable discussing their ideas outside the classroom: nor, did they identify themselves as having sufficient knowledge to contribute to a submission. In conclusion, this study highlights two points. First, that discussion based transfer learning can be used in the tertiary sector and students value the opportunity to apply their knowledge to socio-scientific issue. Second, if social participation and democratization of science is a goal, then more emphasis should be placed on how students can realistically and confidently apply their learning to change social policy. In order to achieve this, education programs need to focus on legitimate real-life processes such as the PSB for engagement.

Key words: Psychoactive Substance Act, Psychoactive Substance Bill, democratization of science, undergraduate education, transfer learning theory, societal engagement

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One of the goals of undergraduate education should be to develop scientists that contribute positively to society. One example being the ability to use their scientific knowledge to critique government policy and make submissions where appropriate (DeBoer, 2000; Singer et al., 2012). There is very little research, however, on whether true democratization of science occurs, nor how to achieve this. Our aim was to develop a teaching paradigm that connected the undergraduate's neuropharmacological and toxicological knowledge to that of government policy that was undergoing submission using the Psychoactive Substances Bill (Psychoactive Substances Bill 2013) and the Psychoactive Substances Act (Psychoactive Substances Act 2013). Throughout this paper we will refer to the Psychoactive Substances Bill as the PSB. The PSB was passed by parliament in July 2013 and, subsequently, is correctly termed the Psychoactive Substances Act (PSA). Where we discuss the legislation that was under review we will refer to the PSB; whilst when we are referring to the final legislation that was passed by parliament, we will refer to the PSA. As expected, there were differences between the final PSA and the draft PSB. These differences will be mentioned when appropriate.

The PSB was undergoing submission in May 2013 and was designed to cope with the unregulated use of psychoactive substances commonly known as 'legal highs' in the New Zealand public. 'Legal highs' refer to a vast range of chemical entities including the synthetic cannabinoids (i.e., JHW-018) and party pills (i.e., piperazine, trifluoromethylphenylpiperazine) that are consumed for recreational use (Gibbon, 2012; Vandrey et al., 2013). The corresponding Act (PSA) that was accepted into law by parliament in July 2013, has radically changed the drug laws in New Zealand (Wilkins et al., 2013). Before its introduction, any psychoactive substance could be legally sold in New Zealand unless it was banned by the Misuse of Drugs Act 1975 (Misuse of Drugs Act 1975). Banned drugs under this Act included Class A (i.e., cocaine, heroin), Class B (i.e., morphine, amphetamine), and Class C (i.e., cannabis plant and seed). The limitation of prohibition is the delay between the identification of the harmful substance and its subsequent ban. For example, it took over eight years for benzylpiperazine, a CNS stimulant, that has similar psychoactive effects to amphetamine and 3,4-methylenedioxymethamphetamine (MDMA) (Bye et al., 1973; Campbell et al., 1973, Lin et al., 2009) to be classified as Class C and hence illegal to manufacture, sell and consume in New Zealand (Misuse of Drugs [Classification of BZP] Amendment Act 2008). In contrast, the PSA requires the manufacturers/supplier of any psychoactive substance including party pills, energy pills, and herbal highs to provide scientific evidence to prove that their product is 'low-risk' to the consumer. Thus the New Zealand government has changed from prohibition to regulatory framework similar to medicines regulations whereby the manufactures/seller/importer of a new psychoactive substance must have their product either approved or rejected by the government based on the company's preclinical and clinical data. This is a novel approach, to the legal high problem and some have

supported it as "good example of the start of evidence-based policy" (Nutt as quoted in Slezak, 2014) and was passed by the Parliament by 119 votes to one.

At the time of this workshop, the PSB was under public review and submissions were still being accepted by the Parliamentary Select Committee. This was a rare opportunity whereby a legislation that was directly related to neuropharmacology and toxicology was being debated in the public arena. Therefore, we designed a semi-structured workshop around the PSB that allowed the students to discuss the strengths and limitation of the Bill. A questionnaire was designed to address whether participating in the workshop enhanced their understanding of the PSB and its relationship to their established neuropharmacological knowledge (hereafter referred to as 'transfer learning'). Furthermore, whether they felt that they had enough expertise to consider making a submission (hereafter referred to as 'societal engagement').

MATERIALS AND METHODS

Course and Student Information: The Human Toxicology (PHAL306) course at the University of Otago, New Zealand is restricted to third year science majors that have taken two pharmacology courses in their second year including Introductory Pharmacology (PHAL211). PHAL211 introduces the concepts of pharmacodynamics and pharmacokinetics and has 10 neuropharmacology lectures including two lectures on drug dependence. This workshop was designed to fit within a toxicology course partially due to practical constraints (teaching slot availability). Both toxicological and neuropharmacological knowledge were important for the discussion of the PSB, especially when discussing the preclinical data that would be required to determine that a psychoactive substance is 'low risk.' By working with third year students we felt confident that the cohort would have sufficient neuropharmacological and toxicological understanding to allow us to test their ability to transfer this knowledge to a new setting. Note that the Bachelor of Science degree in New Zealand has a duration of three years. Student numbers fluctuate every year, but the class size is normally between 20-40 students. In 2013, there were 23 students enrolled in the class and of these eleven people attended the workshop. While these numbers are limited we felt the responses captured the key elements of the workshop and are a fair representation of the class. Due to the timing of the PSB submission process there was no opportunity to repeat the study. PHAL306 runs for 13 weeks and consists of 23 one-hour lectures and six, three-hour laboratories. In this paper we only discuss the 50-minute workshop.

Rationale for running this as a workshop instead of a lecture: Most tertiary education institutions rely heavily on lectures as a primary teaching tool despite the findings from several studies showing that over-reliance on lectures can leads to gross misconceptions (Schwartz and Bransford, 1998). Halpern and Hakel (2003) have suggested that lectures work well for information that is required to be rote learned, however, lecturing does not help students develop understanding or deep learning (identification of underlying concepts). Furthermore, these authors suggest that 'learning is generally enhanced when learners are required to take information that is presented in one format and re-represent it in another alternative format.' This principle relates to the learning theory of 'transfer': that is the ability for a student to translate information from one situation and apply it to a novel situation (Schunk, 1996). The ability to apply knowledge across situations is gaining popularity as a key outcome of education (Boekaerts, 1999). It was our aim, therefore to provide the students with a guided opportunity that would allow them to practice transferring their neuropharmacological and toxicological knowledge to the public arena using the PSB. In addition, Anderson et al. (1996) suggested that 'transfer' learning theory works best when students are aware of what they are expected to apply their previous knowledge to and therefore students were pre-warned of the discussion topic, and it was stressed to them that we were trying to model a situation whereby they were being expected to apply their neuropharmacological and toxicological knowledge to government policy. On Blackboard, we placed the following documents to aid the discussion:

- Psychoactive Substances Bill 100-1 (Feb 2013) (New Zealand Parliament)
- Basic guide to pre-clinical toxicology testing (summary information produced for students on this course)
- Criteria for absorption from the gut for drug-like compounds (Gad, 2008)
- Status of non-animal methods that are relevant to drug development (Gad, 2008)
- Key absorption, distribution, metabolism, and elimination parameters and methodologies for preclinical studies (Gad, 2008)
- Animal models used in preclinical testing of pharmaceuticals (Gad, 2008)
- Standardization of data collection and meta-analysis (Gad, 2008)
- Source of prior knowledge (Gad, 2008)

Resources were selected for their relevance to the subject matter at hand and their accessibility to the students. We carefully chose resources that we knew our students would be able to interpret (e.g., they did not include any overly complicated statistics or legal terminology).

Psychoactive Substances Bill: The PSB was draft legislation that was open for public submission at the time of the workshop. In response to these submissions the Bill was redrafted to form the final version of the PSA. Several aspects of the draft Bill that were highlighted in the discussion section were updated before the Act was approved in July 2013. Two key aspects of the PSB that were emphasized during the discussion session were (a) the lack of definition of 'low risk', nor how this was going to be determine and (b) no mention of proof that the psychoactive substances had efficacy.

Evaluation of the workshop by the students: A day following the workshop, the students were given a questionnaire that was designed to address whether participating in the workshop enhanced their understanding of the PSB and its relationship to their established knowledge (transfer learning) (Table 1). Furthermore, whether they felt that they had enough expertise to consider making a submission (i.e., societal engagement) (Table 1).

Question	Answer (response as a 100%)			
1. Did you attend the workshop?	Yes = 100%		No = 0%	
2A. Were you aware of the psycho-active substance bill before the workshop?	Yes = 64%		No = 36%	
2B. Did you support the bill before the workshop?	Yes = 9%	No = 9%	Was undecided = 64%	Did not indicate on sheet = 18%
2C. Did the workshop change your opinion?	Yes = 27%		No = 46%	Did not indicate on sheet = 27%
3. Would you have assumed that the psychoactive substance bill would have included the following: ▪ The definition of low risk ▪ That the drug had to be proven effective as a psychoactive substance	Yes = 100% Yes = 100%		No = 0% No = 0%	
4. By participating in the session do you think that you have gained a better understanding of this bill and its relationship to your studies in pharmacology and toxicology?	▪ Yes = 36% ▪ Yes, although background reading was required. ▪ Yes, helped me to see the effect it could have on the use of psychoactive substance for beneficial things other than recreational use. ▪ Yes, learned about parts that had been left out of the bill. Related to topics we have learned about. ▪ Yes, it made me think about aspects of the bill from a more pharmacological (design) aspect and made me question what it was about rather than accepting what was written in the bill. ▪ Yes, had no idea about what it really meant until this section. ▪ Yes, I did not know about the finer points of the bill. However, I don't believe the discussion attributed to my studies. ▪ Yes, the ability to pose question and topics then for other people to comment on these and pose their own questions etc made for a more involved educational experience, as well as increasing insight where I may not have thought to think beforehand.			
5. Did you find the process of discussing the bill to be interesting and worthwhile? Can you give a reason why or why not?	▪ Yes, because it allowed me to think instead of zoning out. Also because it was less formal than a lecture, I felt more comfortable asking questions and participating in the discussion. ▪ Yes, it was a different king of pharmacology that we don't see too much of in the undergraduate course. ▪ Yes. ▪ Yes – hearing why people supported it or opposed it and certain features more interesting ▪ It was very interesting and a different way to test your knowledge of pharmacology and toxicology as poking holes in the pharmacological aspects of the bill (e.g., efficacy, risk, definition of substance). Emphasize some important basic principles of pharmacology and toxicology. ▪ Yes, made me think about topics that I have not thought of. Able to see both side of the debate. ▪ Yes, interesting to hear others opinions. ▪ It was interesting, however, there was not enough time to discuss all that was needed. Especially in regard to animal testing as this is the aspect which will be examinable. ▪ Yes interesting to find out what these things actually mean. ▪ Yes, it was good to get insight on how the government thinks. However, I believed that the bill protect pharmaceutical companies rather than the public. ▪ Yes I found it easier to remember topics when discussed.			

Table 1. Summary of responses to the questionnaire.

6. Would you have preferred this session be presented in another way? If yes, what would you suggest as an alternative format?	▪ No. ▪ No, it was good being informal (jokes etc), people were more likely to participate. ▪ Good session but needed participation, without it, it could have been a waste of time whereas a lecture would convey the information regardless of participation but has the potential to be bad. ▪ No – was good but I don't think it was structured enough. Would have liked you to pose more questions to structure the discussion. Too off topic a lot of time so lost interest. ▪ No. ▪ Unsure. Like structured sessions with objectives like normal lectures. ▪ No, good format. Need to be more clear which we needed to take from the session (for exam study this was challenging). ▪ Hearing a lecture presentation about it then get opinions. I found it hard to understand the bill, itself. ▪ Only that when people state the opinion on the matter that they get time to explain it. Rather than other immediately stating disadvantages or putting it down. ▪ Yes and no. While I may remember more I'm unsure of what exactly needed to be taught for the sake of examination. For general knowledge I prefer this type. For examination purposes a structural lecture would make me feel more comfortable about what knowledge is required for the exam.
7. Write any additional comments on your experience with the psychoactive substance bill workshop here.	▪ I would have like it better if we had a lecture on the topic beforehand, or the workshop is longer (e.g., 2 hrs instead of one). That way, the taking in of information is not too rushed. ▪ Give clear indication at the end of the session about what is needed for the exam and what is just for interest. ▪ Enjoyed it, feel that I actually took away the information directly from class without going over it again. ▪ More focus and direction in the discussion would be nice/less tangents.
8. Do you think as a student or graduate in pharmacology and toxicology you would consider making a submission to a bill or regulation such as the one we discussed? Can you give a reason why or why not?	▪ I would consider making a submission to a similar bill because I think as the bill is concerned with pharmacology and toxicology, it is better to construct the bill with someone that has a basic background in these fields. This leaves less loopholes and makes the bill more effective as it was meant to. ▪ No, doesn't interest me too much. ▪ No, don't feel I have enough knowledge compared to the experts on the select committee to added anything new to discussion. ▪ Yes, as a graduate or student, you still have a greater knowledge of pharmacological aspects that will be important to put in the bill. ▪ No, don't feel I have enough understanding of both pharmacology and the submission to a bill. ▪ Yes our knowledge is specific to the drugs and may be helpful in generating new law that is efficient and good for NZ. ▪ The bill should define what psychoactive means and make clearer definitions. ▪ Yes – seems stupid that they will let them sell something without even proving that it works. ▪ Not 100% what is included in a submission. However, if it is to tell them what should be included or excluded then no. ▪ Yes/no, as someone working in pharm/tox department then yes, as I could pose questions to colleagues before submitting otherwise no.

Table 1 continues. Summary of responses to the questionnaire.

RESULTS AND DISCUSSION

Refer to Table 1 for summary of the responses to the questionnaire. It was surprising that 36% of the class had not heard about the PSB despite the bill being directly associated with their studies and widely discussed in the media (Table 1). The majority of those that had heard of the PSB, indicated that they were undecided about the bill (Table 1). The questionnaire was done anonymously, however, due to the class size, students may have felt that handwriting could be linked to an individual and hence the safest answer was 'undecided.' Two students did not indicate whether they support the bill or not and left this question blank but filled out the rest of the questionnaire. The workshop only changed the opinion of a minority in the class. We did not feel that it was appropriate to ask *how* the workshop altered their opinion since the workshop was designed without a political agenda.

In the PSB, the definition of what low risk was not stated. The PSB stated 'a psychoactive product that is approved for the use by individual should pose no more than a low risk of harm to individual using it… the degree of harm posed by the product to individual who use it should be assessed by the Authority on the basis of:

1. The advice of an expert advisory committee; and
2. Evidence, including the results of preclinical and clinical trials.

The advisory committee was proposed to have six members who 'between them must have appropriate expertise in: pharmacology, toxicology, neuroscience medicine, and other areas the Authority considers relevant.' This generated a lot of discussion with the students. First of all, 'low risk' does not mean 'no risk' and this is an important consideration since if a psychoactive substance is approved by the government the public could make the assumption that the government is indicating that the drug is safe to take. We prompted the students to apply their content knowledge of pharmacokinetics (what the body does to the drug - i.e., differences in metabolism) and pharmacodynamics (what the drug does to the body – i.e., receptor density, receptor efficacy etc) to explore the idea that no drug is completely safe and that the response to a drug is variable. With support, from teachers and peers, all the students were able to see how their prior knowledge of psychoactive substances could be transferred to the discussion around safety of new medications. This supports the idea that students needed help to develop their ideas and see the links between concepts (Anderson, 1996), even though as teachers we often presume students make these links easily.

Another point that generated a lot of discussion was whether a recreational drug should be held to the same standard as a drug that is used to treat a disease. Using their clinical trial design knowledge students were able to talk about how the decision to take a drug to treat a disease is based on the risk of side effects and adverse drug reactions versus the benefit of treating the disease. For recreational drug use, there is no risk versus benefit analysis due to there being no therapeutic effect (limited perceived benefit) therefore it could be suggested that the standards should be higher than a medicine.

The PSB also touched on many societal issues of harm. For example, whether drug abuse causes problems to other citizens and not just the individual taking it (e.g., psychoactive substance-induced impairment of driving). The students were able to develop an understanding of issues in the drug approval processes that they had not previously been aware of. This section of the workshop involved many "light-bulb" moments on the part of the students as they began to form an overall picture of science in a societal context. As teachers this was exciting, watching the students assimilate their knowledge into a broader understanding was very rewarding. It also supports the need for different teaching methods in the classroom (Halpern and Hakel, 2003). Despite many lecture based sessions, some explicitly on the social dilemmas in drug design and approval, the students developed their own understanding only when given the freedom and space to do so.

As mentioned previously, we discussed the PSB, not the PSA that was approved in July 2013. The lack of definition of 'low risk' in the PSB was changed extensively following public submissions. In the PSA, the Advisory Committee must have the following information on the psychoactive product:

- 'the specific effects of the product, including pharmacological, psychoactive and toxicological effect; and
- the potential for use of the product to cause death; and
- the likelihood of misuse of the product; and
- the potential appeal of the product to vulnerable populations; and
- any other matters that the Authority considers relevant.'

The PSB defined a psychoactive substance as 'a substance, mixture, preparation, article, device, or thing that is capable of inducing a psychoactive effect (by any means) in an individual who uses the psychoactive substance.' This is rather a broad definition and does not clearly define what a psychoactive effect is, nor does it mention efficacy. This allowed students to apply their content knowledge of neuropharmacology to define what constitutes a psychoactive substance (i.e., euphoria, CNS arousal, memory enhances, changes in mood, hallucinations, etc). This point also generated a lot of discussion with the students. The majority of students had only thought about psychoactive substance in the term of those that produce euphoria (this is the context in which the Bill was being discussed in the media) and did not consider that the PSB could also be used to sell cognitive enhances, hypnotics, and stimulants for study aids.

We were also able to talk about the placebo effect. A therapeutic drug is not approved unless it is determined in a clinical trial to treat the disease. Most students agree that the manufactures need to prove that the psychoactive substance had efficacy. Talking about the PSB gave us the chance to reinforce the clinical trials information that was taught to them to them at second year and reinforce key terminology such as efficacy and placebo. Students were also able to observe why precision of terminology is so important as it allows joint understanding of a key concept. Within the legal framework precision is very important and the opportunity to compare these two situations was an interesting exercise for both students and teachers.

Overall, the students enjoyed the workshop and felt that it enhanced their understanding of neuropharmacology and toxicology (Question 4: Table 1). That is, content transfer had occurred. Most were happy with the workshop format, however, two students would have liked a lecture before the workshop and one student would have preferred a lecture only. Like most universities, the majority of our teaching is via the lecture format and by third year the students are very familiar with this and not used to the workshop format. However, based on this feedback, the majority of students preferred the workshop format for this kind of discussion.

We ran this as a semi-structured workshop and did not provide the students with the questions that we were going to ask prior to the session because we wanted to have the opportunity to follow discussion points that arose through the discussion itself. One criticism we received (refer to questions 6, 7, and 8 of Table 1) is that the workshop needed more structure. We suggest that this is due to the students overarching concern with assessment outcomes: this is reinforced by comments that they wanted to know what was required for the exam. Therefore, next time we

may look at assessing the workshop itself (although experience suggests this changes the discussion dynamic) or alternatively we could provide the students with the discussion questions beforehand.

Another criticism was the length of the workshop. We chose a 50-minute lecture time slot, however, we underestimated the degree of engagement with the topic and the amount of conversation that was generated. It would have been more appropriate to schedule it during one of the three-hour laboratory sessions. If this was to be the case, we would provide a raft of discussion questions such as:

1. What preclinical data would you require to approve a psychoactive substance was 'low risk'? Points that could be discussed include:
    - How did you measure euphoria/drug dependence in animals? Are there differences in drug metabolism between humans and rodents? Would this affect the exploration of the data from rodents to humans?
    - What type of toxicological data is required? (one species, many species? Which tissues? What assays?)
2. What clinical data would you require to approve a drug was 'low risk'? Points that could be discussed include:
    - What is the appropriate length of a clinical trial (one off exposure or repetitive exposure)?
    - What drug protocol should be used (should it mimic what occurs in recreational drug use: that is binge taking, most likely consumed with other drugs including alcohol and nicotine)?
    - What would be your inclusion/exclusion criteria for the human subjects (i.e., age range, male or females, lack of mental illness)?
    - What would you measure? Is there a euphoria rating scale?
3. Do you think that ethanol and nicotine would be approved by the PSA? Why or why not?
4. A psychoactive substance can be withdrawal under the PSA. What pharmacovigilance (or post market surveillance) would be appropriate for a psychoactive substance?
5. What recourse should a person who has suffered an adverse drug reaction following the recreational use of a psychoactive substance have? Should they be able to ask for the cost of their hospital care from the supplier or perhaps the government since it is the government who is allowing the drug to be sold to the public?

It is important to note that the PSA does not provide a formal framework for several of these issues. Instead, it is the task of the Advisory Committee to determine whether the information provided by the manufacturer is enough to prove that the drug has 'low risk'.

Students, at the end of the workshop, should be given the following article from experts in the field to reinforce concepts learned:

- Green AR and Nutt DJ (2014) This article details, using MDMA and mephedrone as examples, how preclinical and clinical information should be obtained for psychoactive substances.
- Wilkins C. (2014) This article should reinforce concepts around the PSA discussed in class.

Lastly, the students indicated they would generally feel uncomfortable discussing their ideas outside the classroom: nor, did many of them identify themselves as having sufficient knowledge to contribute to a submission. We found this to be a surprising result from students who are close to completing a three-year science degree and indicates that the students underestimated the extent of the expertise they had developed during their studies. Research suggests that students tend to over-estimate their knowledge in a self-assessment exercise, rather than underestimate as they did in this instance (Krueger and Dunning, 1999). Self-assessment research suggests that students generally become better at self-assessment of knowledge over the course of their studies, although this was generally limited to looking at comparisons with achievement on academic assessment (De Wever et al, 2009) rather than asking students to compare their knowledge to a "lay-person." However, a possible critical factor in asking students to evaluate their knowledge in this context is that students will automatically compare their knowledge and understanding to the teaching staff. Having been immersed in an academic environment for three years we suggest that they underestimate the knowledge they have gained because they are in a bubble of experts. On leaving this environment we would hope that they will reassess the amount of knowledge they have gained. However, if social participation and the democratization of science is a goal, then we suggest that more emphasis should be placed on how students can realistically and confidently apply their learning to change social policy. In order to achieve this, education programs need to seek opportunities to incorporate learning involving legitimate real-life activities such as the PSA for engagement.

The outcome from this workshop was that such sessions are a powerful tool to help students transfer their learning from the academic to the public arena. The situation that led to the implementation of this workshop was unusual. It is rare that legislation is being proposed that so closely aligns with concepts covered in the classroom. However, from this study we sought to determine if social issues could be used to inspire students and help them connect their learning to the "outside" world. Our results show that students struggled to make these connections themselves as we observed ("had no idea what it [the bill] really meant until the workshop"). This process has reinforced our own commitment to seeking out areas where the science we teach crosses into society debates. While we acknowledge that this particular legislation debate is unlikely to occur again however, we have been lobbying for time in our teaching timetable for times to address societal issues. These may include a local debate on access to medications, human rights issues around drugs of abuse, an international debate on the cost of medications and health insurance, or animal use in experiments. This study has convinced us that sessions that allow students the time and space to assimilate their knowledge with a wider picture are a

valuable learning tool. To this end we will be looking for the first applications for new medicines under the Psychoactive Substances Act; however, these may be several years away. In the interim we will continue to bring outside issues into the classroom wherever and whenever we can.

REFERENCES

Anderson JR, Reder LM, Simon HA (1996) Situated learning and education. Educ Res 25:5-11

Boekaerts M (1999). Self-regulated learning: where we are today. Int J Educ Res 31:445-457.

Bye C, Munro-Faure A, Peck A, Young P (1973) A comparison of the effects of L-benzylpiperazine and dexamphetamine on human performance tests. Eur J Clin Pharmacol 6:163-169.

Campbell H, Cline W, Evans M, Lloyd J, Peck AW (1973) Comparison of the effects of dexamphetamine and 1-benzylpiperazine in former addicts. Eur J Clin Pharmacol 6:170-176.

DeBoer (2000) Scientific literacy: another look at its historical and contemporary meanings and its relationship to science education reform. J Res in Sci Teach 37:582-601.

De Wever B, Van Keer H, Schellens T, Valcke M (2009). Structuring asynchronous discussion groups: the impact of role assignment and self-assessment on students' levels of knowledge construction through social negotiation. J Comput Assist Learning 25:177-188.

Gad SC (2008) Preclinical development handbook. Toxicology. Hoboken, NJ: Wiley-Interscience.

Gibbons S (2012) 'Legal highs'- novel and emerging psychoactive drugs: a chemical overview for the toxicologist. Clin Toxicol (Phila) 50:15-24.

Green AR, Nutt DJ (2014) Pharmacology should be at the centre of all preclinical and clinical studies on new psychoactive substances (recreational drug use). J Psychopharmacol 28:711-718.

Halpern D, Hakel MD (2003) Applying the science of learning to the University and beyond: teaching for long-term retention and transfer. Change: The Magazine of Higher Learning 35:36-41.

Krueger J, Dunning D (1999) Unskilled and unaware of it: how difficulties in recognizing one's own incompetence lead to inflated self-assessments. J Pers Soci Psychol 77:1121-1134.

Lin JC, Bangs N, Lee H, Kydd RR, Russell BR (2009) Determining the subjective and physiological effects of BZP on human females. Psychopharmacology (Berl) 207:439-446.

Misuse of Drugs Act, New Zealand Statutes (1975). Retrieved August 31, 2015 from http://www.legislation.govt.nz/act/public/1975/0116/latest/DLM436101.html.

Misuse of Drugs (Classification of BZP) Amendment Act, New Zealand Statutes (2008). Retrieved August 31, 2015 from http://www.legislation.govt.nz/act/public/2008/0005/19.0/DLM1152221.html.

Psychoactive Substances Act, New Zealand Statutes (2013). Retrieved August 31, 2015 from http://www.legislation.govt.nz/act/public/2013/0053/latest/DLM5042921.html?src=qs.

Psychoactive Substances Bill, New Zealand Statutes. Retrieved August 31, 2015 from http://www.legislation.govt.nz/bill/government/2013/0100/6.0/DLM5042921.html.

Slezak M (2014) High as a Kiwi. New Scientist 221:40-45

Schunk DH (1996), Learning theories. New Jersey: Prentice Hall, Inc.

Schwartz DL, Bransford JD (1998) A time for telling. Cogn Instr 16:475-522.

Singer SR, Nielsen NR, Schweingruber HA (eds) (2012) Discipline-based education research: understanding and improving learning in undergraduate science and engineering. Washington, DC: National Academies Press.

Vandrey R, Johnson MW, Johnson PS, Khalil MA (2013) Novel drugs of abuse: a snapshot of an evolving marketplace. Adolsec Psychiatry 3:123-134.

Wilkins C (2014) A critical first assessment of the new pre-market approval regime for new psychoactive substances (NPS) in New Zealand. Addiction 109:1580-1586.

Wilkins C, Sheridan J, Adams P, Russell B, Ram S, Newcombe D (2013) The new psychoactive substances regime in New Zealand: a different approach to regulation. J Psychopharmacol 27:584-589.

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