A MODEL FOR EVALUATING THE IMPACT OF SIMULATION BASED LEARNING ENVIRONMENTS

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ABSTRACT
As the education and training community continues to rapidly embrace simulation based learning for developing practitioners, the task of evaluating the impact of this learning approach is pivotal. Specifically, understanding the learning impact from the field based practitioner point of view is of equal importance to investigating the technical adequacy of the simulation in the training environment. This paper discusses the design and application of a 4 phase model for evaluating simulation based learning which extends evaluation beyond the training environment to the field of application. The model offers examples based on completed evaluation studies with NSW Police Force simulation based learning exercises. The qualitative and quantitative data collection design extended the evaluation process to include listening to the ‘voices from the field’, i.e. the officers’ field based perspective, and offers an insight into the impact of the exercises in relation to application of learning in the field of operation. The model develops an understanding of key elements of the simulation which influence application in the real world i.e. realistic scenarios, real time customised scenario feeds and time constraints. This format of evaluation contributes to the continuous improvement process in the design and delivery of simulation based learning exercises for practitioners. A major finding from the application of the model to two police training based case studies was the differentiation required in levels of realism for achieving learning outcomes. The pre, post, and field based evaluation model has potential for adaption and application across a wide spectrum of simulation based learning which seeks to build the capacity of learners for their respective operational practices.

1. INTRODUCTION
As the education and training community continues to embrace simulation based learning, understanding the impact of this learning approach remains pivotal on many levels. Evaluating the simulation has the potential to inform on simulation design, financial and human resourcing, learning program design and efficacy of the simulation learning approach. A wealth of work has been undertaken in the pursuit of understanding how to assess learners in simulation based learning environments. Health and allied professions, aviation and military organisations are among the leaders in this domain (see Adamson & Kardon-Edgren, 2013; Golling, et al. 2015; Rybing, et al. 2015; Lucktar-Flude, et al. 2014). The earlier work of Bell and Waag (1992) followed by the seminal work of Salas et al (2003) offered foundational contributions in leading the simulation based education and training community in recognising the value of evaluation. The area of less prominence in the literature is how to approach the evaluation of the simulation activity and environment for its contribution to learner development beyond the training environment. Appreciatively, in the global environment commercial intelligence protocols and sensitivity associated with specific training environments has the potential to limit the sharing of how to evaluate simulation design. Further it also limits the sharing of lessons learnt from evaluations. The importance of evaluating learning approaches is well documented (see Cook & Ellaway, 2015; Cook et al., (2012), Toetenal & Renties (2016), Immrs et al (2016)) for the insight it provides from a learning design perspective and the contribution to balancing financial investment with simulation based learning.

This paper offers and discusses a model for designing the evaluation of simulation exercises and environments for the value they contribute to learner development. The model, which has been applied to a variety of simulation based learning exercises in the police training environment is offered as a base guide to those new to the simulation based learning environment. For those more experienced in this field the model has the potential to aid review of current evaluation approaches.

The model offered has foundations drawn from the seminal work of Kirkpatrick (1959, 1975, and 1994) which has defined an evaluation methodology for assessing learning programs. Kirkpatrick (1959, 1975, and 1994) refers to four steps in the evaluation process:

- Step 1 Reaction: evaluates how participants respond to the training, how well they liked the learning process;
- Step 2 Learning: measures what was learnt – what did they know before and after;
- Step 3 Behaviour: considers if they are using what they learned on the job, a more contemporary category would be performance; and
- Step 4 Results: evaluates if and to what extent the training impacted the learner and organization.

Whilst the model presented in this paper does not utilize the identical Kirkpatrick steps it does embrace the concepts associated with each of the four steps in the Kirkpatrick approach.

Importantly, the model combines qualitative and quantitative data collection methodology for the collective and complimentary contribution this strategy has to offer the evaluation. This approach to data collection within the model resonates with the trend observed by Oliver (2000) in stating:

Just as mainstream evaluation has recognised that different methodologies have their own strengths and weaknesses; a similar position is now accepted within the context of learning technology. Several
authors have advocated using qualitative and quantitative methodologies in order to triangulate results (e.g. Jones et al., 1996), thus enhancing the credibility of evaluation findings (Breen et al., 1998).

There is no intention within the model to include evaluation of the financial resourcing of simulations and simulation based learning. As indicated by Oliver (2000) this is a highly problematic and complex area. The many and varied factors to be captured in a financial evaluation combined with the challenge of quantifying in financial terms the impact of the simulation based learning approach is a continuing conundrum. The model may assist with contributing the value of the learning dimension to the financial costing analysis.

Further, the evaluation of the technology and technical componentry design of simulations is not an intrinsic element of the evaluation model presented here. Historically, the evaluations which have been conducted utilizing the model under discussion in this paper have contributed to the continuous improvement of technical elements of simulation based learning exercises and environments for which the evaluation was conducted. The findings emanating from the application of this evaluation model have the potential to inform a diverse body of stakeholders: educational designers, technologists, topic experts, instructors and curriculum developers.

An explanation of each phase in the model is offered accompanied by examples of application. The examples are drawn from evaluations completed for NSW Police Force training programs which include technology supported simulation based learning exercises and environments. The number of participants contributing to the evaluations ranged between 90-100% of the available participant cohort. The explanation of the phases is followed by a working guide of the evaluation model. The individual phases and steps of the evaluation model were applied to two case studies. Case Study One comprised 742 novice police students undertaking shoot/don’t shoot simulation exercises. Case Study Two comprised 30 senior police officers undertaking an Incident Command and Control decision making simulation exercise/.

2. Phase One

2.1. Step One

Arguably the most influential phase of the evaluation. Phase One contains the considerations and determinations of the fundamental purpose of the evaluation. It is here that the aims of the evaluation are to be identified, these in turn will influence the questions to be utilized in surveys and interviews during the data collection/evaluation process. The aims will guide the reporting of the evaluation findings, the aims provide the categories under which to include the evaluation data. Importantly, establishing the aims provides direction for the distribution of the findings to the appropriate stakeholders.

Table 1 offers an example of the relationship between Aim, Survey Question, and Response. The example is drawn from the evaluation of a NSW Police Force student police training program which includes participation in a simulated use of force (firearms) VirTra simulation exercise (see Davies, 2014). A total of 742 participants completed the survey this was 100% of available participants. The participants were early career police officers in their probationary year.

<table>
<thead>
<tr>
<th>Table 1: Aim: potential influence of simulation on field based practice – participant perspective</th>
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</thead>
<tbody>
<tr>
<td><strong>The Aim</strong></td>
</tr>
<tr>
<td><strong>Survey Question</strong></td>
</tr>
<tr>
<td><strong>Example Response</strong></td>
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</table>

2.2. Step 2

Step 2 requires consideration of establishing the learners’ current level of knowledge and skills in the area to be demonstrated in the simulation participation. This enables a potential comparison in the level of competency, pre, post and field based of the specific knowledge and skills. In parallel, this approach enables understanding of the contribution and influence of the simulation participation on the learners’ development of knowledge and skills.

The assessment/measurement tools to be applied will depend on the nature of the knowledge and skill area and the extent to which these may be measured. There is opportunity for formal testing, informal observation, learner self-assessment and or Instructor assessment.

2.3. Step 3

The final step in Phase One seeks to establish the Instructors’ expectations for the influence of the simulation based learning exercise on learner development. This a key area of consideration as it offers the potential to inform on the simulation exercise/scenario design. Establishing the expectations pre-simulation enables a comparison with the post simulation results, in particular when aligned to the learning objectives and outcomes for the exercise.

An example drawn from an Incident Command and Control simulation for senior NSW Police Officers is presented in Table 2.

<table>
<thead>
<tr>
<th>Table 2: Aim: Instructor perspective of adequacy of simulation environment</th>
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<tbody>
<tr>
<td><strong>The Aim</strong></td>
</tr>
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</table>
3. Phase Two

3.1. Step One
Phase Two, Step One offers opportunity to understand the adequacy of the simulation exercise and environment for participants to demonstrate the requisite knowledge and skills. Whilst the assessment of the learners’ performance from a formal training perspective is not the central focus of this evaluation model, this may contribute to the overall understanding of the adequacy of the simulation exercise and environment. The example in Table 3 is drawn from Case Study Two.

Table 3 offers an example of an evaluation aim, focused on the adequacy of the environment, associated survey question and response drawn from the evaluation of a NSWPF training program with simulation based learning.

### Table 3: Aim: adequacy of simulation to enable application of knowledge and skills

<table>
<thead>
<tr>
<th>The Aim</th>
<th>To develop an understanding of the adequacy of the simulation exercise and environment in providing opportunity for participants to demonstrate their knowledge and skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Question</td>
<td>During the pre-simulation interview, you discussed the expectations for this simulation exercise, please can you explain whether these expectations were achieved or not, and why this occurred.</td>
</tr>
<tr>
<td>Example Response</td>
<td>The simulation exercise is very full on and it did allow, and we saw this occur, opportunity for the learners to apply their Incident Command and Control model knowledge.</td>
</tr>
</tbody>
</table>

3.2. Step Two
Phase Two, Step Two is of pivotal importance to those involved in the design of simulation based learning exercises and environments. This step offers opportunity to learn from the simulation participants the elements/features of the simulation which have the potential to provide major influence on the sense of immersion, engagement, presence and realism of the simulation. It is important to acknowledge the level of practitioner experience of the learners when seeking feedback on this area of the simulation design.

Appreciatively, the frame of reference in responding to surveys at this stage of the evaluation process is markedly diverse. Those who are able to compare the simulation exercise and environment with their prior field based experience will offer a valuable contextualised and experienced based contribution. The less experienced or those with nil experience will have a limited reference point from which to offer an informed response. The frame of reference for the less experienced officer is more advanced at the point of the interview phase of the evaluation process. Table 4 presents an example phase, survey question and response associated with the post simulation participant perspective on the simulation elements which influence immersion, engagement, presence and realism.

### Table 4: Aim: Influence of simulation environment on immersion, engagement, presence and realism

<table>
<thead>
<tr>
<th>The Aim</th>
<th>To develop and understanding of the simulation elements which aid immersion, presence, engagement and realism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Question</td>
<td>Please identify the elements of the VirTra simulation which you consider assisted in providing a realistic scenario</td>
</tr>
<tr>
<td>Example Response/s</td>
<td>The sound effects helped make the scenario more realistic; the sound effects, language and timing were really good, what I would expect in the real world.</td>
</tr>
</tbody>
</table>

4. Phase Three

4.1. Step One
Phase Three, Step One is at the centre of understanding the contribution of the simulation based learning exercise participation as a conduit to transferring learning from the classroom to the field of practice. It is here that the voices from the field have the potential to inform on the design and conduct of the simulation based learning exercise. Conducting surveys and interviews offers opportunity to gather quantitative and qualitative data. Interviews enable a richness and depth of explanation from participants which may not be realised through survey alone. The example in Table 5 is drawn from Case Study One.

### Table 5: Aim: Influence of simulation experience on transfer of learning

<table>
<thead>
<tr>
<th>The Aim</th>
<th>Develop an understanding of the influence of simulation based learning on the transfer of learning from the simulation environment to the field of operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interview Question/s</td>
<td>Following your experience in the field in making decisions about the use of your firearm, can you tell me how the simulation training experience affected your decision-making in the field? And Were you aware at the time of the incident in the field of reflecting on your experience in the simulation unit? How did this impact your decision in the field? Please explain.</td>
</tr>
</tbody>
</table>
4.2. Step Two

The final step in the model associated with collecting data from the participants is centred on participant comparison from the field based perspective on the level of realism experienced in the simulation. Here listening to the voices from the field, it is their lived experience which has the potential to inform on this vital feature of the simulation based learning exercise and environment.

The point of difference between Phase Two Step Two and Phase Three Step Two is that irrespective of the level of knowledge and skill the learner has pre- and during the simulation, their field based reflection comes from the reality of operational experience. Table 6 presents an example aim, interview question and response in respect of the field based perspective on level of realism experienced in the simulation environment.

Table 6: Aim: field based perspective of level of simulation realism

<table>
<thead>
<tr>
<th>The Aim</th>
<th>Develop an understanding of the sense of realism created in the simulation based learning exercise and environment.</th>
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<tbody>
<tr>
<td>Interview Question</td>
<td>When you now reflect on your experience in the VirTra simulation exercises, how realistic do you think they were? Please explain.</td>
</tr>
<tr>
<td>Example Response/s</td>
<td>Definitely, the domestic was realistic, at the time I didn’t think it would be like that but having dealt with domestics like that in the field and having to use the capsicum spray. I like in the VirTra I thought he was coming straight for me but he went to his missus, which I have seen in the field but not with a knife. (P.5)</td>
</tr>
</tbody>
</table>

There were humans, real threats and sense of danger, the same as the one I went to a couple of weeks ago me and another female officer. He [Person of Interest] had broken bail conditions, was intoxicated ... and he approached with a knife. (P.8)

... [it was] very realistic, the sight, sound, timing, I am in a rough area so am constantly thinking and trying to be aware, at the end of the day there is always the likelihood of a gun or knife being involved in the incidents we attend. (P.3)

5. Phase 4

The final phase of the model is the analysis and presentation of the evaluation findings and recommendations aligned with the initial aims of the evaluation.

There is potential for the content of the report to contribute to the continuous improvement of a wide collection of the simulation based learning exercise and environment. Instructional design, technology support, simulation scenario case preparation to name a few.

The distribution will be dependent on the initial aims of the evaluation as identified by stakeholders. Figure 1 depicts the relationship between key stakeholders and the areas in which the evaluation model has the potential to inform, including but not limited to:

(a) Adequacy of the simulation based exercise context and content to support learning objectives;
(b) Adequacy of the simulation scenario to contextualise application of learning;
(c) Influence of the simulation elements to support learning e.g. noise, light, tactile characteristics;
(d) Adequacy of the simulation exercise to support learning transfer;

6. CONCLUSION

The model offered in this paper for the evaluation of simulation based learning exercises has realised valuable contributions to the design and conduct of exercises within the police training environment.

Specifically, the model has contributed to understanding the level of fidelity required by novice and experienced practitioners to aid transfer of learning from the classroom to the field of practice. The model is offered as a basic framework to mold and adapt dependent on the learning context in which it is to be applied. The intent is to contribute to the wider simulation based learning community through aiding rigorous evaluation of simulation based learning initiatives.

7. REFERENCES


AUTHOR

Dr Amanda Davies, is a Senior Academic and Course Manager with the School of Policing Studies at the NSW Police Force Academy, Australia. Dr. Davies holds a Doctor of Philosophy and a Masters of Information Technology. Dr. Davies has published extensively on the influence of simulation based learning in police/law enforcement education with specific focus on optimising learning outcomes. To inform the curriculum development work Dr. Davies undertakes in the field of police education and training, is her work in evaluating police/law enforcement training programs including Active Shooter Training, Use of Force Training, Field-based officer leadership training, Major Public Order Incident Command Training and Emergency Services Training. Dr Davies is the recipient of a Vice Chancellor Award for Teaching Excellence and an Australian Learning and Teaching Council Award (Prime Minister’s Award) for innovation and quality in teaching and learning practices. Dr Davies more recent work is focused on the development and evaluation of educational design models which embed simulation based learning exercises as a conduit for aiding learner transfer of theory into professional practice. This work encompasses both the online virtual learning space and the face to face learning environment.
### Simulation Based Learning
**A Simulation Evaluation Guide**

<table>
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<th>Phase 1 Pre-Simulation</th>
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<tr>
<td><strong>Phase 1</strong></td>
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</tbody>
</table>
| **Step 1** | Identify the aims of the evaluation | - Develop an understanding of what new knowledge and skills were learned  
- Develop an understanding of the influence of the simulation based learning participation on the transfer of training to operational practice  
- Develop an understanding of the elements of the simulation based learning exercise and environment which support:  
  (a) knowledge and skill development  
  (b) transfer of learning | Identify availability of data collection tools e.g. Commercial off the shelf survey tools; independent research agencies; Internal/external research capacity |
| **Identify/establish learning outcomes** | - What skills and knowledge are learners to demonstrate in the simulation exercise | - Demonstrate application of the conflict management model  
- Demonstrate application of situational awareness strategies | Align learning outcome expectations with simulation exercise design |
| **Establish Assessment criteria** | - Align assessment criteria to learning outcomes  
- Identify assessment tools: formal or informal assessment  
  (a) Learner Self-Assessment  
  (b) Instructor Assessment | - Rubric identifying learning outcomes and levels of achievement and/or  
- Listed knowledge and skills to be demonstrated and associated grading e.g. satisfactory/unsatisfactory competent/not yet competent | Establishing the learner assessment tools informs on the adequacy of the simulation environment to enable demonstration of the requisite knowledge and skills to be assessed |
<table>
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<tr>
<th>Phase 1</th>
<th>Element</th>
<th>Example</th>
<th>Simulation Evaluation Tools</th>
<th>Example of Simulation Evaluation Tools</th>
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<tbody>
<tr>
<td>Step 2</td>
<td>Assess Learners’ pre-simulation level of knowledge and skills</td>
<td>Identify Learners’ expected influence of the simulation exercise on learning</td>
<td>Options: 1. Survey (online and or hard copy) 2. Interview (telephone, video link, face to face, focus groups)</td>
<td>Example Survey/Interview Questions:  - What learning do you expect to gain from the simulation exercise?  - How do you expect participating in the VirTra simulation scenarios will influence your future policing practice in the field?  - I expect to have my decision-making skills tested in the VirTra simulation scenario/s (answer options: very strongly agree, strongly agree, agree, undecided, disagree, strongly disagree, very strongly disagree);</td>
</tr>
<tr>
<td>Step 3</td>
<td>Identify Instructors’ expected influence of the simulation exercise on learning</td>
<td>Options: 1. Survey (online and or hard copy) 2. Interview (telephone, video link, face to face, focus groups)</td>
<td>Example Survey/Interview Questions:  - What aspects of the simulation exercise will have the greatest influence on the decision making in the exercise?  - What aspects of the simulation exercise do you consider are the most important?  - What elements of the simulation exercise do you consider support learner engagement? Immersion? Presence?</td>
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</table>
## Phase 2 Post-Simulation

<table>
<thead>
<tr>
<th>Phase 2</th>
<th>Element</th>
<th>Example</th>
<th>Simulation Evaluation Tools</th>
<th>Example of Simulation Evaluation Tools</th>
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</table>
| Step 1  | Identify influence of simulation exercise on learners’ knowledge and skills | • Combine formal/informal assessment of learner demonstrated knowledge and skill application with learner perspective of influence of simulation exercise on their development Note – the assessment tool utilised to measure learner development will be determined by the respective training program of which the simulation is a component. | Options:  
1. Survey (online and or hard copy)  
2. Interview (telephone, video link, face to face, focus groups) | Example Survey/Interview Questions:  
The following three questions included answer options - very strongly agree, strongly agree, agree, undecided, disagree, strongly disagree, very strongly disagree  
• The VirTra simulation scenarios provided an opportunity for me to apply my decision-making skills.  
• I was able to apply key decision-making skills I learnt from the course.  
• What value/benefit do you consider the VirTra simulation experience will add to your policing in the field?  
• What were the most valuable aspects for your future policing practice gained from participating in the simulation exercise? |

| Step 2  | Identify simulation elements which influenced learner development  
*See Note below | Options:  
1. Survey (online and or hard copy)  
2. Interview (telephone, video link, face to face, focus groups) | Example Survey/Interview Questions:  
• Please identify the elements of the VirTra simulation which you consider assisted in providing a realistic scenario: Sound effects, Timing (reflective of real time), Surround Screens, Language, Characteristics of participants, other – Please list;  
• I consider I was continuously engaged and immersed in the simulation exercise answer options - very strongly agree, strongly agree, agree, undecided, disagree, strongly disagree, very strongly disagree  
• Please comment on the sense of realism you experienced with the simulation exercise |

Note: Learners with no prior experience in their field of practice have less potential to provide an informed response in relation to the realism of the simulation environment and exercises at immediate post simulation exercise. If such questions are used for this group, an accompanying question identifying their prior level of experience would aid clarity of their perception of the realism/immersion/presence/engagement elements of the simulation.

Note: Learners with experience in their field of practice have the potential to provide an informed response in relation to the realism/immersion/presence/engagement elements of the simulation environment and exercises.
## Phase 3 Field Based

<table>
<thead>
<tr>
<th>Step</th>
<th>Element</th>
<th>Example</th>
<th>Simulation Evaluation Tools</th>
<th>Example of Simulation Evaluation Tools</th>
</tr>
</thead>
</table>
| Step 1 | Identify the influence of simulation based learning on transfer of learning | • Combine formal/informal field based assessment of learner demonstrated knowledge and skill application with learner perspective of influence of simulation exercise on their field based practice | Options: 1.Survey (online and or hard copy) 2.Interview (telephone, video link, face to face, focus groups) | Example Survey/Interview Questions:  
  • Are you aware of reflecting on the simulation experience and lessons learnt and applying that knowledge in your field based decision making?  
  • How helpful to assisting you to transfer the learning from the program to your operational practice were the simulation exercises? Please can you explain your answer and provide examples which indicate the connection between the simulation and your application of knowledge and skills in the work place.  
  • Following your experience in the field in making decisions about the use of your firearm, can you tell me how the simulation training influenced your decision-making?  
  • Were you aware at the time of the incident in the field of reflecting on your experience in the simulation unit? How did this impact on your decision? |
| Step 2 | Identify elements of simulation based learning which influence transfer of learning | • In Phase 3 all learners' have field based experience from which to reflect on the realism elements of the simulation | Options: 1.Survey (online and or hard copy) 2.Interview (telephone, video link, face to face, focus groups) | Example Survey/Interview Questions:  
  • When you now reflect on your experience in the VirTra simulation exercises, how realistic do you think they were?  
  • Did you feel at the time that the simulation exercise created an atmosphere reflective of real time?  
  • On reflection of the simulation exercise and environment to what extent did you feel immersed?  
  • What elements of the simulation exercise and environment influenced the sense of realism?  
  • What elements of the simulation exercise and environment influenced the engagement you experienced? |
## Phase 4 Continuous Improvement

<table>
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<tr>
<th>Phase 4</th>
<th>Compilation of Evaluation Report</th>
<th>Example Inclusions</th>
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</table>
| Step 1  | Address Aims as listed in Phase 1, Step 1 | • Quantitative data identifying number of learners who considered simulation was realistic  
• Quantitative and qualitative data identifying the elements learners considered influenced the transfer of learning to the workplace  
• Qualitative data identifying learner perception of skill and knowledge influenced by simulation experience |
| Step 2  | Identify recommendations for continuous improvement of the simulation based learning exercise and environment to support learner development | • Distribution of findings to inform on:  
(a) Design of the simulation scenario content  
(b) Design of the technical components of the simulation environment  
(c) The contribution to learning achieved through participation in the simulation based learning exercise  
(d) The contribution to transfer of learning to operational practice achieved through participation in the simulation based learning exercise |

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