

NPC: an online model to improve prescribing skills of health care professional students in Australia

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The National Prescribing Curriculum (NPC) is a series of case-based modules that mirror the decision-making process outlined in the World Health Organisation's Guide to Good Prescribing. The emphasis is on learners building their own formulary of preferred drugs for specific conditions thereby enabling them to prescribe confidently and rationally. The modules were developed to overcome shortfalls in basic pharmacological knowledge and prescribing skills as identified by junior hospital doctors. Problem Base Learning (PBL) has been used as pedagogical approach for the modules and includes real life case scenarios, authentic tasks and expert peer feedbacks. Learners can access the modules at their own pace and also can revisit them upon completion. We report for the first time students' perceptions of the NPC as learning resource and usability issues, and how academics are embedding the NPC modules into their units. We also discuss limitations and possible areas of improvement.

Keywords: prescribing skills, national prescribing curriculum, online healthcare education.

Introduction

The development of the National Prescribing Curriculum (NPC) was a response to the need expressed by junior doctors in Australia in 2001 (Smith et al., 2006), and prescribing errors and adverse drug reactions that remain the most common cause of injury to hospitalised patients (Nichols et al., 2008, Bobb et al., 2004, Roughhead & Semple, 2008). This percentage of error appears to be increasing and has significant consequences for patient safety (Heaton et al., 2008, Maxwell et al., 2006). This could show dissociation between lectures and clinical reality that health care professionals face when they finish their studies. This gap has been also described in other disciplines like education (Buckingham 2005; Schon 1987; Stigler and Hiebert 1999; Smith 2000). One of the possible reasons of this dissociation can be the fact that some real life situations may not be explained adequately in traditional face-to-face teaching contexts and requires a technological intervention (Reyna, 2011). On the other hand, prescribers are facing progressive demands due to more licensed medicines available, increasing indications for drug treatment, greater complexity of treatment (polypharmacy) and more elderly and vulnerable patients (Maxwell & Mucklow, 2012).

In this regard, online learning as an alternative approach could showcase effective prescribing practices, promote dialog on critical issues in the field, help students to apply theory to practice, and create enthusiasm and confidence in the learner to implement safe practices. There are other factors that could influence prescribing such the environment, team, individual, patient and task (Basket, 2010). Prescribing is an important part of medical practice but may not necessarily be a strong focus in the training of medical students or other health professionals. Safe-prescribing skills and awareness of medication errors is required by all members of the health care team, and should be a core component of undergraduate and postgraduate training programs (Coombes et al., 2008).

In order to overcome these issues, the National Prescribing Services (NPS) decided to develop the NPC as a web-based course founded on the World Health Organization's Guide to Good Prescribing (de Vries, 1994). The resource currently comprises 28 modules covering common therapeutic topics from COPD to Diabetes, polypharmacy, hypertension, lipid management, etc. The modules have been designed for individual, self-paced learning or can be used as part of small group work. Module content is written by subject matter experts and undergoes a rigorous peer-review process, similar to that followed by peer-reviewed journals, during their development. Educational designers review the

content to ensure that it is appropriate for online delivery and that the tasks are meaningful and meet the learning outcomes. Evaluators at NPS design formative and summative research to gather the impact of the modules on students' knowledge construction and to find areas of improvement.

Problem Base Learning (PBL) was identified as pedagogical approach for the NPC modules. This approach was considered to be the most suitable to overcome the gap between traditional didactic lecturing and the clinical reality that their students would eventually face, so we decided to base their instruction on real-case scenarios. Students will need relevant medical knowledge to solve a clinical problem presented on the module. Since the instructors at McMaster University's Faculty of Medicine developed Problem-Based Learning in 1969 (Albanese and Mitchell, 1993; Vernon and Blake, 1993), this pedagogical approach proved to be a successful in the area of medical education. Currently, 70% of medical faculties in the US use PBL in pre-clinical years (Kinkade, 2005). PBL has been successfully implemented in various disciplines, such as architecture (Maitland, 1997), business (Stinson and Milter, 1996), education (Duffy, 1994), law (Driessen and Van der Vleuten, 2000), social work (Boud and Feletti, 1991), engineering (Fink, 1999; Woods, 1994) and physics (Williams, 2001).

The NPC modules have been designed as a logical progression where learners can engage in their own way with their patients, discuss therapeutic goals with their peers, choose the optimal non-drug and drug therapy, prescribe medicines and get expert feedback. Additionally, learners can advise the patient how best to use the chosen therapy and finally, test their knowledge gained using review questions built in with expert's feedback at the end of the module. After completion, the learners can revisit the modules and can print My Formulary that contains the drug classes and prescribed medicine used across the different modules.

Recently, the focus of the NPC has diversified to include other health professionals, and minor adjustments have been made to accommodate this change (e.g. replacing the specific term 'doctor' with a more generic term of 'prescriber'), but the overall structure of the course has been kept the same. It has been shown that short prescribing courses run locally by universities and hospitals enable new prescribers to develop their own personal formulary of preferred drugs for specific conditions and to improve prescribing (Bennett-Levy et al., 2009). The NPC differs from these courses with the fact that is more flexible due to the online nature and it is the only nationally available course for students and health professionals from multiple healthcare disciplines.

Research questions

- (1) Is the NPC a valuable learning resource for the students?
- (2) Are there any usability issues with the module design?
- (3) What are academics perceptions of the NPC?

Materials and Methods

Learning Design

A typical NPC module has the following logical progression: (1) Introduction to the condition and learning outcomes; (2) context/case study that defines who and where the learner is for the purpose of the module; (3) a list of short term therapeutic goals where learner can nominate, vote and see their peers' votes; (4) expert's feedback on therapeutic goals as guidance; (5) consider a non-drug treatment and submit their answers following by expert's feedback; (6) choose the appropriate drug treatment for the condition; (7) verify the suitability of the treatment; (8) select drugs and prescribe online followed by feedback written by the expert; (9) feedback on the prescribed incorrect drugs that may cause adverse reactions; (10) monitor patient progress via multiple choice question and instant feedback from expert; (11) provide information to the patient and followed by the expert's ideas, and; (12) multiple choice quiz to give a quick review of the module. Every time learners submit their answers they will get an instant expert feedback.

The NPC follows the 3 essential characteristics of a good learning design according to Britain (2004): (1) learning is active; (2) activities are presented in a logical progression; and (3) the template is reusable. The delivery method is for self-paced learning but flexible enough to be use in face-to-face tutorials. In fact many academics introduce the modules on tutorials at the beginning of the semester and provide the login details for the students.

As the NPC content is written by content experts with vast clinical experience, the case study presented in each module is authentic. The tasks and the level of interaction that learners get involved promote a conceptualisation of the patient, development of critical thinking and problem-solving skills, considering different ideas of treatment, and meaning of feedback.

Technical specifications

We have developed our modules using Flash professional and they are hosted on a commercial Flash-based e-learning platform. Each module takes learners approximately one hour to complete. Learners access the modules through a self sign-in process, organised through their universities. The main features of the NPC website where the modules are contained can be summarised as: (1) self-registration for students; (2) drugs tool; (3) my formulary tool; (4) writing prescription tool; (5) authoring tool; and (6) monitoring tool.

(1) *Self-registration for students*

The educational designer at NPS creates a group for each university or organisation on the database. Inside these groups, cohorts are created upon academic request at the beginning of each semester. When a cohort is created and modules are included, the educational designers assign a course key and email sign-up instructions for students to relevant academics. Students for each of these organisations have to self-register into their university and course. The self registration page can be found at www.nps.org.au/npc.

(2) *Drug tool*

The drug tool is a database that is organised by condition and it is classified in drug classes. A drug class might have lots of brands of products under it. Each product comes with information such efficacy issues, safety issues, commentary and resources. Inside the drug class there are different types of products available and contain details such drug name, form, strength, directions, quantity, repeat, cost, other issues and commentary. Links with additional information are placed inside the drug tool. Most of the links comes from the Australian Medicine Handbook (AMH), Therapeutic Guidelines (eTG) and NPS website. This is an example to visualise the structure of the drug tool; *Drug Class* > *Anti-infectives* > *antibacterials* > *aminoglycosides* > *drug name: Gentamicin*. Each module has a drug tool that allows learners to choose a medicine at the time of prescription.

(3) *My formulary tool*

This is a centralised application that takes input from the drug tool. It stores the drug choices from students as well as their notes and in which modules they have chosen them. It also implements a My Formulary page that will display the drugs that the students have added to it (when and by which module they have added them). Additionally, the Formulary tool provides data for the Write Prescription tool so the student can choose which drugs they need to write a prescription.

(4) *Writing prescription tool*

This is a tool that allows students to complete and submit an online prescription with the drugs they selected for their patient in a previous step. When they submit this prescription they will get expert feedback. Learners are able to search for drugs in their formulary, select drugs for the prescription, enter doctor, patient and drug details into the prescription, preview and print the prescription (if desired) and get feedback from an expert on the correct prescription. The prescription tools have the same fields as those used in Australian public hospitals and general practice and look similar.

(5) *Authoring tool*

This area is exclusively for the educational designer and contains the sequence of activities covered in the learning design part. This section allows the designer to build the series of interactions the module will follow.

(6) *Monitoring tools*

This section is for academics who want to see their student progress. The grade book is a functionality that allows gathering information of the whole cohort and reports on a spreadsheet the activities of all the students inside the cohort, particularly currently visited and completed modules. This is a useful feature for academics.

Methodology

Online surveys and forms were used to gather quantitative and qualitative data. All NPC registered students at the time of the study (n=4,339) were invited to participate on a voluntary base. A link to a cross-sectional questionnaire containing 18 questions was e-mailed to students. The questionnaire captured demographics of participants, completion of modules, student's attitude and perception of usefulness. Quantitative data was analysed using SPSS v.19. Descriptive statistics were calculated for all variables. Analysis was undertaken for all questions of all applicable respondents. Qualitative responses were analysed using a structured process in which key phrases and concepts were identified, the data categorised, and recurring themes and issues recorded. NPC usage data was gathered from the server for year 2011. Due to system setup and limitations, data on usage implied a tedious manual process, which is the reason why it was done only for last year. Additional qualitative data from academics was gathered at the time they were requesting a new NPC cohort via online form early in January 2012.

Results and discussion

Demographics of participants

A total of 442 (10%) valid surveys were received and almost all respondents had completed at least one module (94%, n=417). Among the entire sample almost two thirds were female (66%, n=292). The highest proportion of respondents were from New South Wales (NSW) (28%, n=125). The next highest proportion of respondents were from Victoria (VIC) (21%, n=94) and Queensland (QLD) (16%, n=71); there was also considerable response from Tasmania (TAS) (14%, n=63).

Approximately 80% of all respondents were studying medicine. The remaining respondents were made up primarily of pharmacy students (14%, n=62) and nurse practitioners and dentistry. This makes sense as the modules were primarily targeted for medical students but pharmacist and nurse practitioners are finding the NPC modules relevant and useful for their disciplines.

Completion of modules

Although the greatest proportion of respondents indicated that some or all of the modules were compulsory (58%, n=257), it is also of note that almost one quarter of those who completed a module indicated that they were not compulsory (25%, n=109) (Table 1). A quarter of all respondents also indicated that the modules were linked to assessment (26%, n=113). Students most commonly completed 4 modules (15%, n=62). However, there were 52 students (13%) who completed all 25 modules.

Table 1: Use of the modules in the curriculum

	% (n)
Modules not compulsory	25 (109)
Some/all modules compulsory	58 (257)
Some/all module completion counted to course mark	13 (56)
Some/all modules linked to assessment	26 (113)
Other	4 (18)

Chronic obstructive pulmonary disease (COPD) was the module completed by the greatest proportion of students (64%, n=266). This is also the first module to be displayed in the series of modules which may influence the uptake and completion by students. Other frequently completed modules include chronic heart failure (59%, n=247), post-operative pain (56%, n=234) and acute pulmonary oedema in chronic heart failure (49%, n=205) (Table 2).

Table 2: Top 10 NPC modules completed

	% (n)
M1: COPD	64 (266)
M9: Chronic heart failure	59 (247)
M4: Post-operative pain	56 (234)
M8: Acute pulmonary oedema in chronic heart failure	49 (205)
M16: Polypharmacy in multiple system failure	49 (204)
M18: Anticoagulation in atrial fibrillation	48 (200)
M11: Acute coronary syndrome	48 (200)
M19: Prophylaxis of deep vein thrombosis	47 (196)
M6: Confusion in an elderly woman	46 (193)
M10: Urinary tract infection	44 (182)

Ranking of usage per module

In calendar year 2011, there were a total of 19,895 completions for all modules by learners across Australian universities from medicine, pharmacy, nurse practitioner and dentistry. Ranking of usage per module has been calculated taking into account the total number of modules completed vs. the specific module figures, for example in M1: COPD there were 1,044 learners that completed this module ($1,044/19,895 * 100 = 5\%$). Data presented on Table 3 shows that the students used the modules evenly. For modules 26 and 27 the percentage of usage were low as they were new modules rolled out 6 months ago when the study was conducted. This data was crucial to decide whether we decommission modules with low usage. Our concern was that students can be overwhelmed by having to complete 28 modules as each module takes 1 hour. Although the data on Table 1 shows that only in 13% of the cases modules are counted towards course mark, so students can decide whether or not to complete the whole set of modules. It will be required in the future to ask the students what they think about having 28 modules, what the optimum number of modules would be to improve prescribing skills? For example, it could be that NPC modules need to cover more modules or fewer modules will be required for students to understand the prescribing process and to feel confident with their skills. To elucidate these questions further research need to be conducted.

Modules names are: (M1) COPD; (M2) Peptic ulceration with H. pylori; (M3) Peptic ulceration with NSAID use; (M4) Postoperative pain and vomiting; (M5) Opioid dependency; (M6) Confusion in geriatric patient; (M7) Confusion associated with alcohol withdrawal; (M8) Acute pulmonary oedema; (M9) Chronic heart failure; (M10) Urinary tract infection; (M11) Acute coronary syndrome; (M12) Chronic angina; (M13) Hypertension; (M14) Respiratory tract infection in a child; (M15) Seizure; (M16) Polypharmacy; (M17) Anaemia; (M18) Anticoagulation for atrial fibrillation; (M19) Prophylaxis in deep venous thrombosis; (M20) Adolescent depression; (M21) Analgesics in persistent pain; (M22) Glycaemic control in long-established diabetes; (M23) Long term management of type 2 diabetes P1; (M24) Long term management of type 2 diabetes P2; (M25) Insomnia; (M26) Opioid analgesics in chronic non-cancer pain; (M27) Lipid management and CVD risk; (M28) Acute mania in bipolar disorder; (D1) Facial pain; (D2) Sore mouth; (D3) Bone problems.

Table 3: Ranking of usage per NPC module in 2011

Module	No. Students completed	%	Module	No. Students completed	%
M1	1044	5	M16	1145	6
M2	852	4	M17	606	3
M3	817	4	M18	795	4
M4	881	4	M19	749	4
M5	584	3	M20	520	3
M6	799	4	M21	681	3
M7	557	3	M22	665	3
M8	964	5	M23	683	3
M9	999	5	M24	651	3
M10	746	4	M25	613	3
M11	781	4	M26	473	2
M12	663	3	M27	363	2
M13	870	4	D3	21	0
M14	531	3	D1	27	0
M15	712	4	D2	103	1

Students' attitude

The general attitude among the student responses towards the module tasks, content, relevance and navigation was overwhelmingly positive (Table 4). There was a high level of agreement (approximately 95%) that the module tasks were engaging, that the instructions easy to follow, the content clearly presented and that the modules were relevant to (anticipated) clinical experience. There was also encouraging results in regards to the module learning objectives which were found to be clear. The tasks in the modules were also found to adequately address the objectives (approximately 95% agreement). Interestingly, more than 40% of students indicated that they would not be more motivated to complete the modules if they were formally assessed. Approximately 30% indicated that the modules did not increase awareness of other NPS products, suggesting improvement could be made in the promotion in the modules of other NPS resources. There was some disagreement (approximately 20%) in the ease of navigation of the modules.

Table 4: Attitudes toward content, navigation, learning objectives and other aspects of the modules

	SA	A	D	SD
	% (n)			
Module tasks were engaging (N=415)	22 (92)	74 (307)	4 (15)	0 (1)
Instructions easy to follow (N=414)	29 (120)	66 (271)	5 (22)	0 (1)
Content clearly presented (N=414)	30 (122)	67 (276)	4 (15)	0 (1)
Relevant to (anticipated) clinical experience (N=414)	38 (156)	59 (244)	3 (14)	0
More motivated if formally assessed (N=414)	21 (87)	39 (161)	37 (154)	3 (12)
Links to other resources useful (N=415)	23 (97)	61 (255)	15 (61)	1 (2)
Increased awareness of other NPS resources (N=415)	18 (75)	51 (213)	28 (117)	2 (10)
Learning objectives clear (N=415)	21 (88)	73 (303)	5 (22)	1 (2)
Tasks addressed the learning objectives (N=417)	23 (95)	74 (302)	3 (12)	0 (1)
Easy to navigate (N=413)	22 (92)	57 (234)	18 (74)	3 (13)

(SA) Strongly agree; (A) Agree; (D) Disagree; (SD) Strongly disagree.

Perception of usefulness of NPC

Approximately 90% of learners positively responded when asked about the impact of the modules on developing critical appraisal skills and, and whether the modules were effective in testing understanding of the content rather than just memory. More than 90% of learners agreed or strongly agreed that the feedback was adequate to guide decision making. Almost all students considered the feedback from experts to be useful (52% strongly agreed and 46% agreed). The usefulness of access to peers' answers and ideas was less but at 80% agreement, the result is still very positive (Table 5). There were also 20% of students who indicated that they were not encouraged to complete the modules and may indicate room for further promotion among academic staff.

Table 5: Attitude towards module feedback, developing skills and encouragement to complete

	SA	A	D	SD
	% (n)			
Effective for developing critical thinking skills (N=412)	23 (96)	65 (266)	11 (46)	1 (4)
Tests tested my understanding – not just memory (N=414)	28 (117)	65 (267)	6 (26)	1 (4)
Expert feedback was useful (N=413)	52 (214)	46 (188)	3 (11)	0
Adequate feedback to guide decision making (N=412)	24 (99)	66 (270)	10 (40)	1 (3)
I was encouraged to complete NPC modules (N=414)	22 (92)	58 (239)	17 (71)	3 (12)
Access to peers' answers/ideas useful (N=414)	23 (95)	57 (235)	18 (74)	2 (10)

It will be necessary to gather students' perspective of what they learn as it has been proved to be effective when evaluating the effect of curriculum innovation on students' learning. This data will identify variations between groups of learners, and will allow conclusions to be drawn about the quality of students' learning. This systematic analysis is known as phenomenography and has been described in educational psychology (Ellis et al., 2007; Matthew *et al.*, 2007; Marton and Booth, 1997; Prosser & Millar, 1989).

Academic perception of NPC modules

When we asked academics (n=38) at the time of sign up for 2012, 64% reported that they use the NPC in both 1st and 2nd semester while only 11% in 1st semester and 6% in 2nd semester. Fifty-two percentages of academics informed that they use the modules for year 4 and 5 students. Only 14% of academics were willing to help NPS with the following tasks: (1) Identifying students to give a testimonial about their experience with the NPC modules for promotional purposes (written or filmed); (2) Research and/or evaluation activities and studies involving the NPC modules; (3) Reviewing/updating the content of the NPC modules. This was not a surprise as we know academics have competing schedules. Additionally, 75% of academics who signed up for NPC in January 2012 had positive comments about NPC as learning resource, as example:

I think NPC modules are relevant, I like the stepwise progression ... they're very thorough ... I really like the emphasis on non-pharmacological treatment to start with, they sort of encourage the student to think about the whole case and the whole patient ... they're also used by the majority of schools and universities in Australia and it's sort of good to know it's a consistent approach being used across the country.

I think that the standard of prescribing both in doctors and medical students needs overall to be improved and I think that the NPC modules are doing an excellent job.

The NPC is a very good resource; it presents a logical progression for students to follow when making clinical decisions. I believe it has a lot of interaction that allow students to engage with it in their own way.

Limitations of NPC modules

There are several limitations of the NPC modules related to functionality, cross device compatibility, and social presence. We are currently working on a strategy to overcome these issues.

The NPC modules have a functionality called grade book that allow academics to export an Excel spreadsheet with the list of their students and stage of completion of the modules. The main limitation of the NPC modules is for assessment purposes, not all of the interactions are captured on the database. List of short term therapeutic goals (Step 3 in sequence) and also providing information to the patient (Step 11) are recorded on a database but this is not accessible to academics on the report. Data on multiple choice questions in: considering a non-drug treatment (Step 5), monitoring patient progress (Step 10) and multiple choice quizzes designed to give a quick review of the module (Step 12) cannot be captured. Medications used by learners in different modules can be exported as PDF but academics will not have direct access to this information. All of these are technical limitations that need to be addressed in order to promote NPC modules into the curriculum as assessment tool for academics.

The NPC interface is design in Adobe Flash which is not compatible with portable devices running iOS platform (Apple devices). Adobe also announced that will not support Flash for mobile devices. These portable devices are changing the way we organise our everyday life, learning resources and tasks;

allowing us to increase productivity. Because of their portability, large display, and touch screen, tablets are ideal devices for one-to-one learning, as well as fieldwork. According to the NMC Horizon Report in Higher Education (2012), tablets have come to be viewed as not just a new category of mobile devices, but indeed a new technology in its own right. They blend features of laptops, smart phones, and earlier tablet computers with always-connected Internet, and thousands of apps with which to personalise the experience. The NMC report mentioned that the time to adoption is 1 year or less. We are currently studying the possibility of migrating our modules from Flash to HTML5, CSS3 and JavaScript in the near future. The aim is to extend cross device compatibility which will help us reach more learners and also improving their learning experiences.

It has been described before that one of the major components of student satisfaction in online learning is the levels of interaction. High levels of interaction result from highly cooperative learning environments (Simonson et al., 2012). Educators are challenged to seek and implement tools and strategies that recreate face-to-face human elements of cooperation, immediacy, intimacy that model physical classroom experiences (Gunawardena & Zittle, 1997). Social presence is the awareness of interaction partners over a communication medium (Short, Williams & Christie, 1976). The NPC modules have a weak social presence and students can only see how their peers replied on the therapeutic goals section (Stage 3) and also in considering a non-drug treatment (Stage 5). A better way to connect learners may be developing an online learning community promoted by instant messages where students can create a profile for online discussion and sharing of resources, etc. In this space learners can discuss and consider ideas and learn from each other in a constructive manner. An online learning community of users will help to create social presence, build cohesion and elevate student's attitudes, performance, satisfaction and student engagement (Ring, 2012).

Additionally, it has been reported the use of video cases in PBL scenarios to be a valuable stimulus for group discussions in medical students. Students thought the video cases enabled them to create realistic mental pictures of conditions, provided integrated pictures of patients as people, which challenged them to elaborate the cases seriously and were more memorable than text-based cases (De Leng et al., 2007). We are considering including digital video in future NPC modules to describe the case scenarios and possible patients concerning. Digital video provides a natural medium for enhancing the sense of context and realism in case studies. It can capture the complexity of real life scenarios and allow students to replay events as many times as they need and absorb important features that escaped them on first viewing (Reyna, 2010).

Limitations of the study

The study has been focused primarily with an evaluation rather than a research approach to estimate how valuable to the students the NPC is as a learning resource. Although the NPC modules follow a Problem-Based Learning approach commonly used in medical education, does not use a conceptual framework to be tested. We are planning in the future to strength our relationship within the universities involving academics in the design process of the NPC modules taking into account a conceptual framework for learning based on a constructive alignment. This will give us opportunities for future research and improving students learning experience.

Conclusions

From the data presented, it is clear that the NPC modules are valuable learning resource for students. This leads to accept the first research question we formulated. We need to promote the NPC modules within pharmacist and nurse practitioners to increase the uptake in these disciplines. It will also be necessary to further evaluate student's perception of learning. A good model could be phenomenography as has been shown to be effective when evaluating technological intervention in the curriculum.

In regards to the second research question about usability of the modules, only 20% of students indicated to have some issues navigating the modules. This could be due to technical issues like Flash player and Java platform. However, when students move to tablet computing, this may become an issue for the drawbacks that Flash has for touch screen interfaces and no compatibility for iOS devices such iPads, iPhones and iPod touch.

Overall academic perceptions about NPC modules were positive and they are up taking the NPC modules within their units, especially for year 4 and 5 students. Limitations in terms of functionality may prevent them from using the NPC modules as assessment tools. Issues with cross device

compatibility, social presence and inclusion of digital video, if addressed, could have a positive impact on student's engagement and enhance the learning experience. We are looking forward to implementing these in the near future.

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