
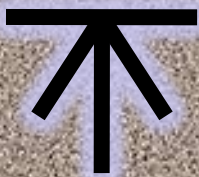


Innovations in Numeracy Support for Healthcare

Establishing a numeracy assessment benchmark in nursing: The focus and design of a NES commissioned research study



NHS Education for Scotland (NES) Numeracy Reference Group

- 
- 
- Mike Sabin (NES)
 - Associate Professor Carol Hall (University of Nottingham)
 - Dr Meriel Hutton (Consultant)
 - Dr David Rowe (Strathclyde University)
 - Dr Keith W Weeks (University of Glamorgan; Authentic World Ltd)
 - Professor Diana Coben (King's College London)
 - Norman Woolley (University of Glamorgan; Authentic World Ltd)

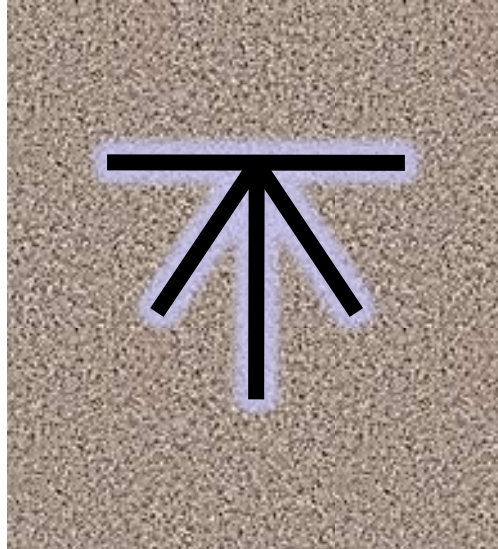
Synopsis of Afternoon Presentation

- The focus and design of our study
 - Focus: validating an evidence based framework within which a benchmark may be articulated
 - Research design: Quasi-experimental study
 - The story so far...
 - Next steps...

Definition of a 'Benchmark'

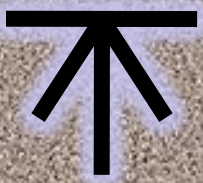
Originally:

- The chiseled horizontal marks that surveyors made in stone structures
- Usually indicated with a chiseled arrow below the horizontal line.
- It was a set point or a place of reference.



More Recently:

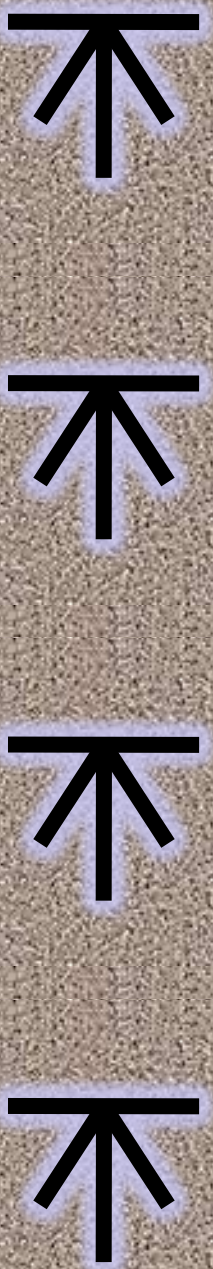
- A point of reference from which measurements may be made
- Something that serves as a standard by which others may be measured or judged
- A standardized test that serves as a basis for evaluation or comparison





What a benchmark assessment should look like: Principles to inform development

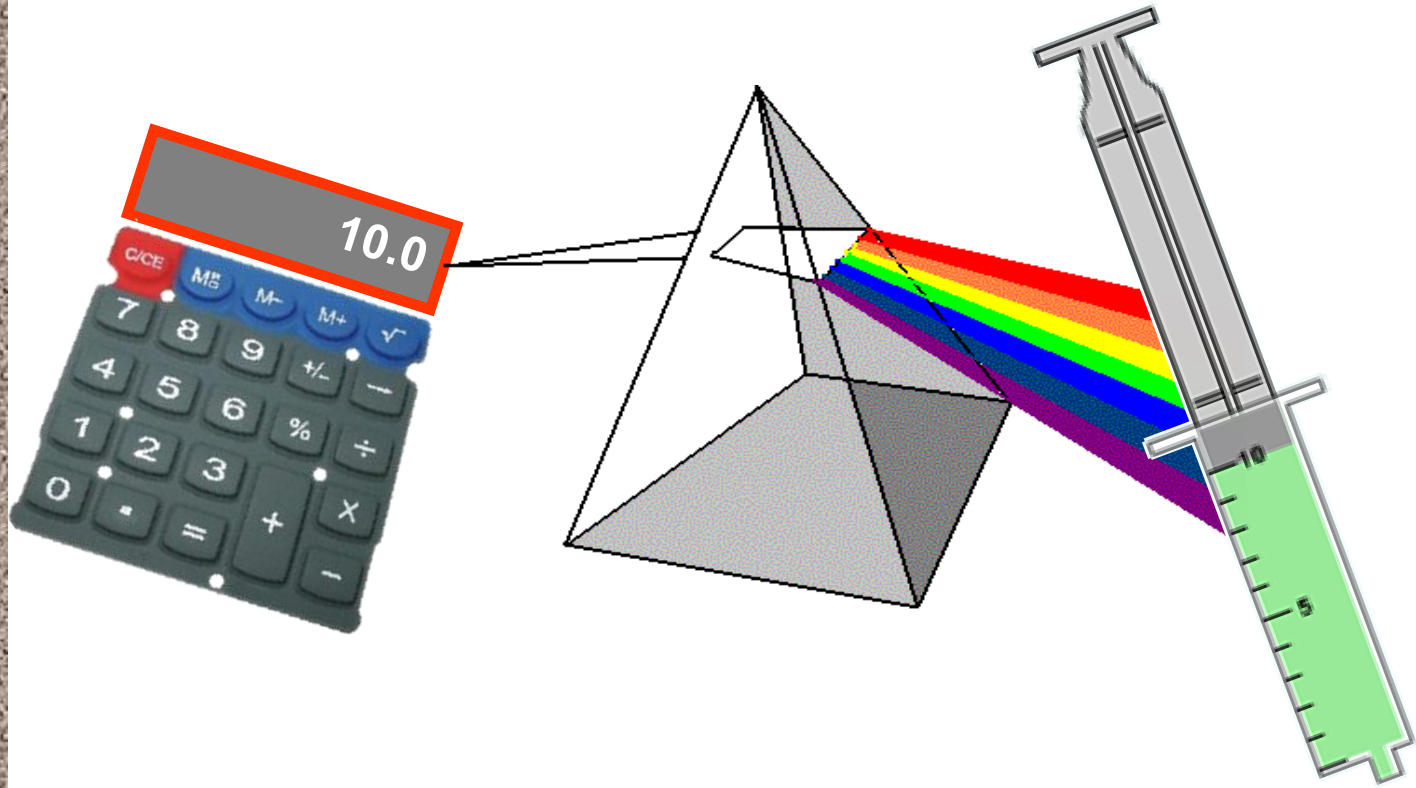
- ***Realistic:*** (Hutton, 1997; Weeks, 2001, 2007)
- ***Appropriate:*** (OECD, 2005; Sabin, 2001).
- ***Differentiated:*** (Hutton, 1997).
- ***Transparent:*** (Weeks et al 2001).
- ***Well-structured:*** (Hodgen & Wiliam, 2006)
- ***Consistent with adult numeracy principles:***(Coben, 2000).
- ***Diagnostic:*** (Wiliam, 2006)
- ***Easy to administer:*** (Black & Wiliam, 1998).



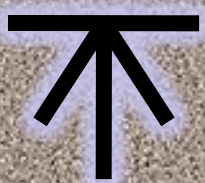
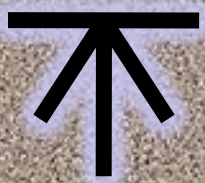
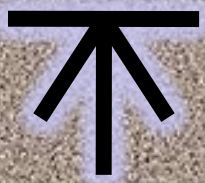
With respect to numeracy for nursing, we consider such an assessment tool should be:

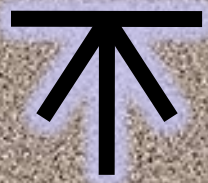
- ***Realistic:*** Evidence-based literature in the field of nursing numeracy (Hutton, 1997; Weeks, 2001) strongly supports a realistic approach to the teaching and learning of calculation skills, which in turn deserve to be tested in an authentic environment. Questions should be derived from authentic settings. A computer based programme of simulated practice in drug calculations, formative testing, with feedback on the nature of errors made, has been shown to improve competency in medication dosage calculation, which can also be demonstrated in the clinical areas (Weeks, Lyne, & Torrance, 2000). Exposure of students to real-world situations is recommended (Weeks, 2001).
- ***Appropriate:*** The assessment tool should determine competence in the key elements of the required competence (OECD, 2005; Sabin, 2001).
- ***Differentiated:*** There should be an element of differentiation between the requirements for each of the branches of nursing (Hutton, 1997).

Transparent

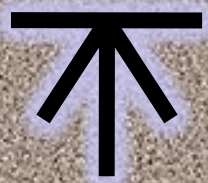


Transparent: The assessment should be able to demonstrate a clear relationship between 'test' achievement and performance in the practice context (Weeks, Lyne, Mosely, & Torrance, 2001).

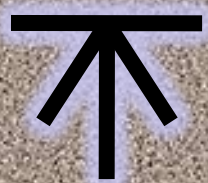
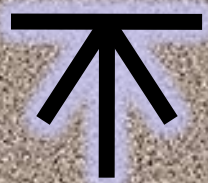




- ***Consistent with adult numeracy principles:*** The assessment should be consistent with the principles of adult numeracy learning, teaching and assessment, having an enablement focus (Coben, 2000).



- ***Diagnostic:*** The assessment tool should provide a diagnostic element, identifying which area of competence has been achieved, and which requires further intervention (Black & Wiliam, 1998). Thus it should “provide information to be used by students and teachers that is used to modify the teaching and learning activities in which they are engaged in order better to meet student needs. In other words, assessment is used formatively to ‘keep learning on track’”. (Wiliam, 2006).



Well Structured, Comprehensive & Diagnostic


| Medication Dosages | | | | | IVI Volume & Rate | | |
|--------------------------|------------------|-----------------|-----------|-----------|-------------------|--------------|-----------|
| | Tablet & Capsule | Liquid Medicine | Injection | Total | | IV Infusions | Total |
| Conversion SI Units | 2 | 2 | 2 | 6 | MI per Hour | 10 | 10 |
| Complex Arithmetic | 2 | 2 | 2 | 6 | | | |
| Sub & Multiple Unit Dose | 3 | 3 | 3 | 9 | Drops per Minute | 10 | 10 |
| Unit Dose | 3 | 3 | 3 | 9 | | | |
| Total | 10 | 10 | 10 | 30 | Total | 20 | 20 |

| | | | | | |
|------------------------------------|-----------|----------|-----------|----------|-----------|
| Grand Total: Questions = 50 | 30 | + | 20 | = | 50 |
|------------------------------------|-----------|----------|-----------|----------|-----------|

The assessment tool should:

- Provide a unique set of questions with a consistent level of difficulty
- Provide a structured range of complexity
- Take place within a defined framework, at points by which students can be effectively prepared, while allowing time for supportive remediation. (Hodgen & Wiliam, 2006)

Five-Dimensional Framework for Authentic Assessment



Task:
Integration of knowledge, skills & attitudes

Meaningfulness, typicality & relevance as perceived by students

Degree of ownership of problem & solution space

Degree of complexity:
▪ Solution space (single / multiple)
▪ Structure (well / ill defined)
▪ Domains (mono / multidisciplinary)

Physical Context:
Similarity to professional workspace (fidelity)

Availability of professional resources (methods / tools)

Similarity to professional time frame (thinking / acting)

Social Context:
Similar to social context of professional practice:
▪ Individual work / decision making
▪ Group work / decision making

Form / Result:
Demonstration of competence by professionally relevant results
Observation / presentation of results
Multiple indicators of learning

Criteria:
Based on criteria used in professional practice.

Related to realistic product / process

Transparent and explicit

Criterion-referenced

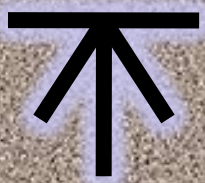
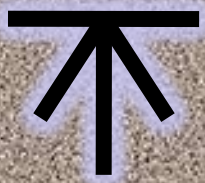
Gulikers JTJ, Bastiaens Th.J, Kirschner PA (2004) A Five-Dimensional Framework for Authentic Assessment. Education Technology Research & Development, 52(3, 67-85)

Easy to Administer



The assessment should provide the opportunity for rapid collation of results, error determination, diagnosis and feedback (Black & Wiliam, 1998).

(Coben et al., in press)



What is Competence in Nursing Numeracy?

It's NOT (for example in the case of an injection dosage problem):

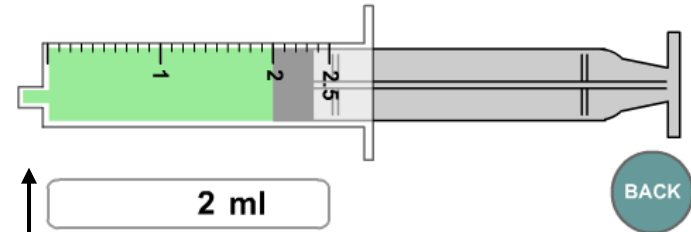
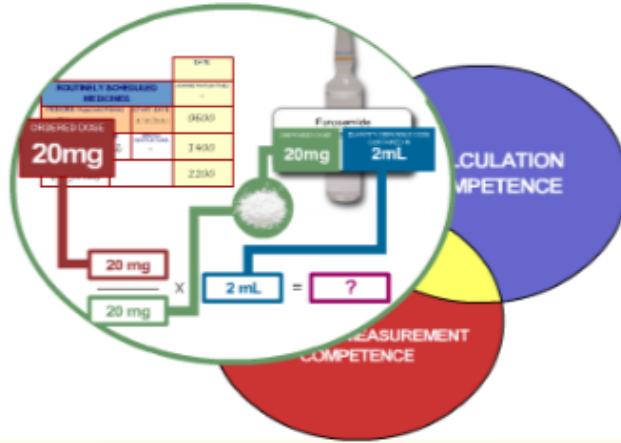
What I want
What I've got X **What it comes in** = **What I give**

Or

20 mg X **2 ml** = **2ml**
20 mg

... but whether, when presented in a particular context with a prescription with a specified dose, an ampoule with a particular strength/volume, and a choice of syringes to draw it up into, that the student and practitioner can manipulate these to produce the correct prescribed dose to be administered.

Authenticity: A fundamental shift in thinking and in the design of learning & assessment environments...



1. Understand & correctly set up the problem to be solved

3. Understand the design of the medication measurement & delivery device; accurately measure the dose to be administered

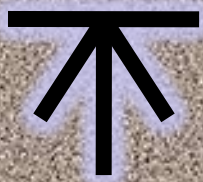
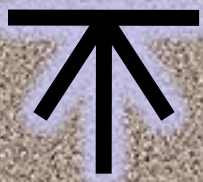
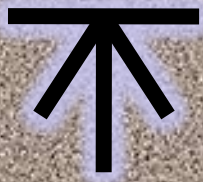
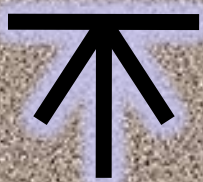
2. Accurately compute the numerical calculation

Divide the **DISPENSED DOSE** into the **PRESCRIBED DOSE**.

$$\frac{20}{20}$$

| TENS | UNITS | • | 0.1 | 0.01 |
|------|-------|---|-----|------|
| | 1 | • | 0 | 0 |
| 20 | 2 | • | 0 | 0 |

X 2 = 2ml



NES programme of research 2007-2009

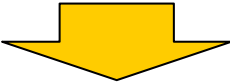
| | | | | | | |
|--|---|---|--|--|--|--|
| Activity | Authentic assessment of medication dosage calculation skills: (N=500 3 rd year students) | Authentic assessment of medication dosage calculation skills: (random/stratified sample by performance: n=100 3 rd year students) | Analysis of Authentic Assessment outcome data | Diagnostic assessment of medication dosage calculation skills: <i>Simulation suite environment</i> | Analysis of simulation suite outcome data | Evaluation of participants perceptions of representative nature of the Authentic Assessment environment |
| 50 students exposed to simulation suite followed by computer based authentic assessment environment | | | Statistical analysis: concurrent validity test | 28 point assessment via examiner observation of typical medication dosage calculation skills in simulation suite environment | Statistical analysis of concurrent validity of Authentic Assessment performance outcomes in comparison to simulation suite setting performance | Evaluation via online Likert scale evaluation tool and focus group interviews. <i>Based on Gulikers' et al (2004) five dimensional framework</i> |
| Process | Sample selected from 6 participating HEI's in Scotland | 50 point Authentic Assessment: <i>Typical unit dose, sub & multiple unit dose, complex problems, conversion of SI units, IV infusions</i> | 50 students exposed to computer based authentic assessment environment followed by simulation suite | | | |

Institutional Ethics Approval

Year Three Adult Cohort - Initial visit to explain project (1 hour)



Stage 1 - Online assessment
(up to 100 volunteers) (2 hours)



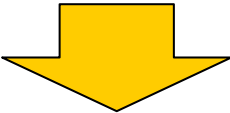
Simulated Clinical Task assessment
10 students (3 hrs)

Online Assessment
(10 Students)

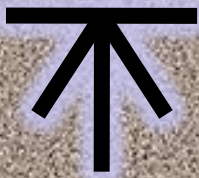
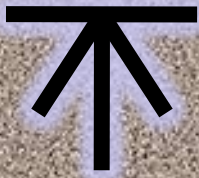
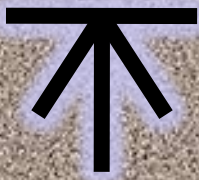
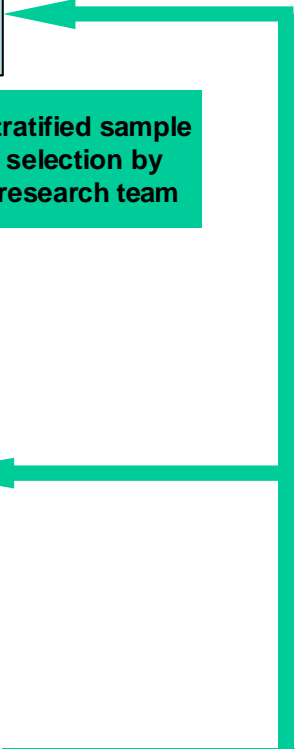
Stratified sample selection by research team

Online Assessment
(10 Students)

Simulated Clinical Task assessment
10 students (3 hrs)



Completion



Key issues arising from the pilot study

- *Pragmatics*
- *Computer based assessment*
- *Practical activity assessment*
- *Congruence between measurement environments*

Assessment Results

BACK

You are reviewing Question 10

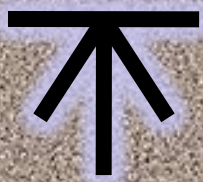
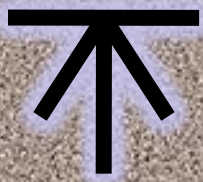
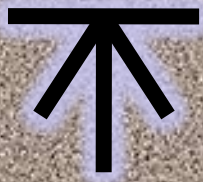
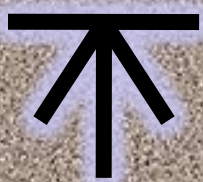
| REGULAR PRESCRIPTION MEDICINES | | | DATE |
|--|-----------------------------------|----------------------------------|--------------------------------------|
| MEDICINE (Approved Name) <i>Digoxin</i> | | START DATE <i>22/4/2008</i> | ADMINISTRATION TIMES <i>06:00</i> |
| DOSE <i>0.125mg</i> | ROUTE <i>ORAL</i> | SPECIAL INSTRUCTIONS <i>-</i> | <i>18:00</i> |
| DOCTOR'S SIGNATURE <i>Dr. Jones</i> | PHARMACY SUPPLY <i>A. Mann</i> | | |



Your Answer



Correct Answer



Assessment Results

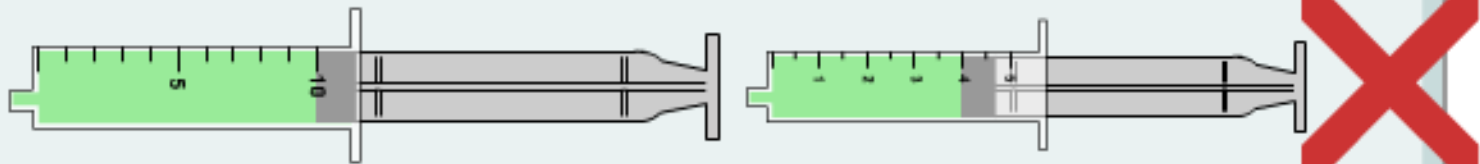
BACK

You are reviewing Question 17

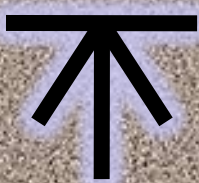
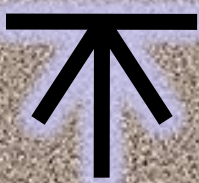
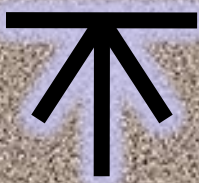
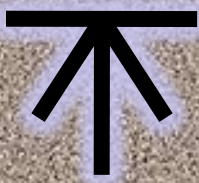
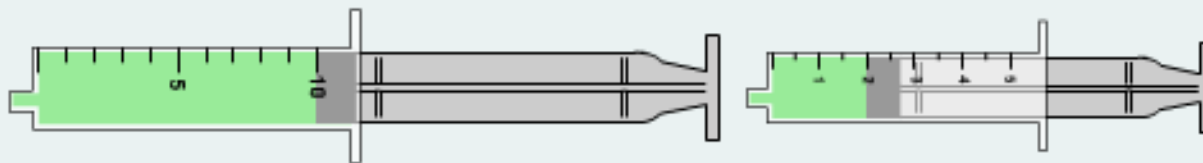
| REGULAR PRESCRIPTION MEDICINES | | | DATE |
|--|-----------------------------------|--------------------------------|---------------------------|
| MEDICINE (Approved Name) <i>Ibuprofen</i> | | START DATE <i>22/4/2008</i> | ADMINISTRATION TIMES - |
| DOSE <i>240mg</i> | ROUTE <i>ORAL</i> | SPECIAL INSTRUCTIONS - | 06:00 14:00 22:00 |
| DOCTOR'S SIGNATURE <i>Dr. Jones</i> | PHARMACY SUPPLY <i>A. Mann</i> | | |



Your Answer



Correct Answer



Assessment Results

BACK

You are reviewing Question 8

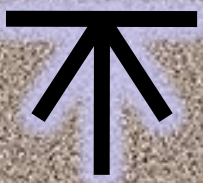
| REGULAR PRESCRIPTION MEDICINES | | | DATE |
|--|-----------------------------------|---------------------------|---------------------------|
| MEDICINE (Approved Name): <i>Theophylline</i> | | START DATE 22/4/2008 | ADMINISTRATION TIMES - |
| DOSE 62.5mg | ROUTE ORAL | SPECIAL INSTRUCTIONS - | 06:00 14:00 |
| DOCTOR'S SIGNATURE <i>Dr. Jones</i> | PHARMACY SUPPLY <i>A. Mann</i> | | 22:00 |



Your Answer



Correct Answer



Assessment Results

BACK

You are reviewing Question 8

| INFUSION FLUID | | | INFUSION DURATION | MEDICINE ADDED | | DR'S SIGNATURE |
|-----------------------------|----------------|-------------|-------------------|----------------|----------|------------------|
| TYPE/STRENGTH | VOLUME | ROUTE | | APPROVED NAME | DOSE | |
| <i>Sodium Chloride 0.9%</i> | <i>1000 ml</i> | <i>I.V.</i> | <i>12 hour</i> | <i>-</i> | <i>-</i> | <i>Dr. Jones</i> |



Your Answer



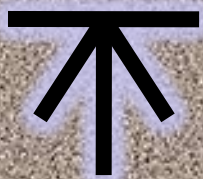
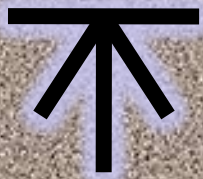
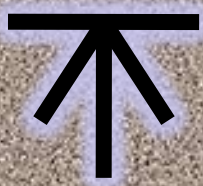
3
drops per minute



Correct Answer



28
drops per minute

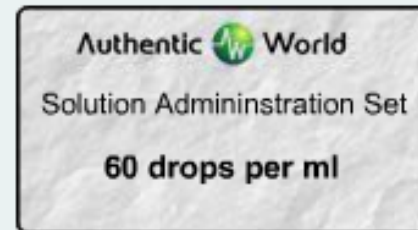


Assessment Results

BACK

You are reviewing Question 6

| INFUSION FLUID | | | INFUSION DURATION | MEDICINE ADDED | | DR'S SIGNATURE |
|-------------------|---------------|-------------|-------------------|----------------|----------|------------------|
| TYPE/STRENGTH | VOLUME | ROUTE | | APPROVED NAME | DOSE | |
| <i>Glucose 5%</i> | <i>100 mL</i> | <i>I.V.</i> | <i>4 hours</i> | <i>-</i> | <i>-</i> | <i>Dr. Jones</i> |



Your Answer



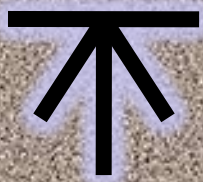
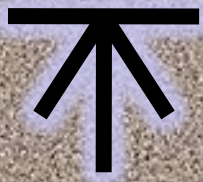
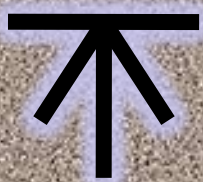
25
drops per minute



Correct Answer



25
drops per minute



The benchmark – Summary

- **Ensure consistency across education providers in meeting the requirements of all stakeholders, be they providers of education, the regulator, employers or the students themselves.**
- **Any benchmark needs to consider the levels of numeracy competence identified above and to include a strong element of process as well as outcome, based on available research evidence.**
- **A test of ability to calculate drug dosages competently by the end of ‘training’ should be the culmination of a programme of education and formative assessment which begins at entry to the programme and is continuous throughout the three years of the programme.**
- **Establishing a robust competence benchmark at this stage** *will allow practitioners to demonstrate achievement, universities to demonstrate effective learning and teaching strategies, and employers to support governance and patient safety.*

References

- Black, P., & William, D. (1998). Inside the Black Box: Raising standards through classroom assessment. *Phi Delta Kappan*, 80(2), 139-148.
- Bruner, J. S. (1975). *Toward a Theory of Instruction*. Cambridge: Belknap/Harvard.
- Coben, D. (2000). Numeracy, mathematics and adult learning. In I. Gal (Ed.), *Adult Numeracy Development: Theory, research, practice* (pp. 33-50). Cresskill, NJ: Hampton Press.
- Coben, D., Colwell, D., Macrae, S., Boaler, J., Brown, M., & Rhodes, V. (2003). *Adult Numeracy: Review of research and related literature*. London: National Research and Development Centre for Adult Literacy and Numeracy (NRDC).
- Coben, D., Hall, C., Hutton, B. M., Rowe, D., Sabin, M., Weeks, K., et al. (in press). Numeracy for nursing: The case for a benchmark. In J. O'Donoghue (Ed.), *The Changing Face of Adults Mathematics Education: Learning from the past, planning for the future. Proceedings of ALM-14, the 14th International Conference of Adults Learning Mathematics - A Research Forum (ALM), held at the University of Limerick, Ireland, 26-29 June, 2007*. Limerick: University of Limerick in association with ALM.
- Collins, A., Brown, J. S., & Newman, S. E. (1990). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In L. B. Resnick (Ed.), *Knowing, Learning, and Instruction: Essays in honor of Robert Glaser* (pp. 453-494). Hillsdale, NJ: Lawrence Erlbaum.
- Condelli, L., Safford-Ramus, K., Sherman, R., Coben, D., Gal, I., & Hector-Mason, A. (2006). *A Review of the Literature in Adult Numeracy: Research and conceptual issues*. Washington, DC: American Institutes for Research.
- Gulikers, J. T. J., Bastiaens, T. J., & Kirschner, P. A. (2004). A five-dimensional framework for authentic assessment. *Education Technology Research and Development*, 52(3), 67-85.

References

- Hodgen, J., Coben, D., & Rhodes, V. (2008, in press). *Formative Assessment in Adult Numeracy*. London: NRDC.
- Hodgen, J., & William, D. (2006). *Mathematics Inside the Black Box: Assessment for learning in the mathematics classroom*. London: nferNelson.
- Hoyles, C., Wolf, A., Molyneux-Hodgson, S., & Kent, P. (2002). *Mathematical Skills in the Workplace. Final Report to the Science, Technology and Mathematics Council. Foreword and Executive Summary*. London: Institute of Education, University of London; Science, Technology and Mathematics Council.
- Hutton, B. M. (1997). *The Acquisition of Competency in Nursing Mathematics*. Unpublished PhD, University of Birmingham, Birmingham.
- Hutton, B. M. (1998). Should nurses carry calculators? In D. Coben & J. O'Donoghue (Eds.), *Adults Learning Maths-4: Proceedings of ALM-4, the Fourth International Conference of Adults Learning Maths - A Research Forum held at University of Limerick, Ireland, July 4-6 1997* (pp. 164-172). London: Goldsmiths College, University of London, in association with ALM.
- Little, J. (2006). Online support for medicine dosage calculations. *British Journal of Nursing*, 15(21), 1192-1195.
- NMC. (2004). *Standards of Proficiency for Pre-registration Nursing Education*. London: Nursing and Midwifery Council.
- NMC. (2007). *Essential Skills Clusters (ESCs) for Pre-registration Nursing Programmes. Annexe 2 to NMC Circular 07/2007*. London: Nursing and Midwifery Council.
- OECD. (2005). *The Definition and Selection of Key Competencies. Executive Summary*. Paris: Organisation for Economic Cooperation and Development.
- Piaget, J. (1983). Piaget's theory. In W. Kessen (Ed.), *Handbook of Child Psychology* (Vol. 1). New York: Wiley.
- Pirie, S. (1987). *Nurses and Mathematics: Deficiencies in basic mathematical skills among nurses. Development and evaluation of methods of detection and treatment*. London: Royal College of Nursing.
- Sabin, M. (2001). *Competence in practice-based calculation: Issues for nursing education. A critical review of the literature. Occasional Paper 3*. London: Learning and Teaching Support Network (LTSN) Centre for Health Sciences and Practice.

References

- von Glasersfeld, E. (1987). *The Construction of Knowledge: Contributions to Conceptual Semantics*. New York: Intersystems Publications.
- Wedege, T. (2003). Sociomathematics: Researching adults' mathematics in work. In J. Maaß & W. Schlöglmann (Eds.), *Learning Mathematics to Live and Work in Our World. ALM-10. Proceedings of the 10th International Conference on Adults Learning Mathematics in Strobl (Austria)* (pp. 38-48). Linz, Austria: ALM and Johannes Kepler Universität Linz.
- Weeks, K. W. (2001). *Setting a foundation for the development of medication dosage calculation problem solving skills among novice nursing students. The role of constructivist learning approaches and a computer based 'Authentic World' learning environment*. Unpublished PhD, University of Glamorgan, Pontypridd.
- Weeks, K. W. (2007). No more 'chalk and talk': Teaching drug calculation skills for the real world. *Safer Healthcare* Retrieved 26 August, 2007, from <http://www.saferhealthcare.org.uk/IHI/Topics/ManagingChange/SafetyStories/teaching+drug+calculation+skills+for+the+real+world.htm>
- Weeks, K. W., Lyne, P., Mosely, L., & Torrance, C. (2001). The strive for clinical effectiveness in medication dosage calculation problem solving skills: The role of constructivist theory in the design of a computer-based 'authentic world' learning environment. *Clinical Effectiveness in Nursing*, 5(1), 18-25.
- Weeks, K. W., Lyne, P., & Torrance, C. (2000). Written drug dosage errors made by students: The threat to clinical effectiveness and the need for a new approach. *Clinical Effectiveness in Nursing*, 4, 20-29.
- Wiliam, D. (2006). Does Assessment Hinder Learning? [Electronic Version] from http://www.uk.etseurope.org/home-corpo-uk/news-home/?print=1&news=136&view=detail&no_cache=1.
- Wiliam, D., & Black, P. (1996). Meanings and consequences: A basis for distinguishing formative and summative functions of assessment. *British Educational Research Journal*, 22(5), 537-548.
- Williams, J., & Wake, G. (2006). Metaphors and models in translation between College and workplace mathematics. *Educational Studies in Mathematics*, 64(3), 345-371.

