

A Generic Framework for Criterion-Referenced Assessment of Undergraduate Essays

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Abstract

This paper presents a brief review of the relative merits of norm-referenced and criterion-referenced assessment of undergraduate students' written work. Acknowledging that there are both positive and negative aspects of criterion referencing, a generic framework for such assessment of undergraduate essays is presented. It comprises criteria and standards (organised by 'dimensions of achievement', i.e. content, process, affect and skills), proficiency standards for English language and communication competence, and cartographic and graphic skills. Problems of implementation include the size and complexity of the framework and the need to interpret and clarify the criteria and standards for students.

Keywords

criterion-referenced assessment; writing skills; cartographic skills; undergraduate essays; norm-referenced assessment

Introduction

Assessment of students' written work is an important issue in geographical education, given that the modes of assessment play a significant role in determining study habits, motivating students, developing learning skills and consolidating learning (Crooks, 1988) as well as influencing students' approaches to learning (Gibbs, 1992; Ramsden, 1992). Furthermore, assessment, from initial conceptualisation to allocation of final grades (not to mention dealing with additional problems such as appeals and plagiarism), occupies a considerable proportion of academics' time and intellectual effort. Streamlining of the process and more efficient use of the time for assessment are clearly desirable, particularly in an environment where student numbers are increasing, resources are decreasing and university managers are advocating 'teaching less and teaching smarter'.

Several aspects of assessment have been conceptualised in terms of simple dichotomies (e.g. formal vs. informal, formative vs. summative, coursework vs. examinations, idiographic vs. nomothetic, etc. (Rowntree, 1987)). In the current Australian context of up-front fees for tuition, students as customers, market orientation, quality assurance and accountability in higher education, and in the context of educational debate about fairness and equity in assessment procedures, another of these dichotomous simplifications has become topical, namely norm- vs. criterion-referenced assessment procedures.

Norm-referenced assessment is defined by Nightingale *et al.* (1996) as:

...assessment ... (which) ... uses the achievement of a group of students to set the standards for specific grades or simply passing or failing. The best X% of students get the best result and the worst X% fail. 'Grading on the curve [1]' is an example of norm-referencing. On the other hand, criterion-referenced assessment establishes standards (criteria) for specific grades or for passing or failing; a student who meets the criteria gets the specified

result. Competency standards may be used as the basis of criteria-referenced assessment (Nightingale *et al.*, 1996, p. 9).

Norm referencing assesses students work by comparison with the work of others, whereas in criterion-referenced assessment the comparison is made with predetermined standards.

Advantages for students of the criterion-referenced approach are as follows:

- they are able to compete with their own previous performance rather than with their peers, the former being considered to be a more powerful performance incentive than the latter (Rowntree, 1987);
- students' grades are based on their own performance, rather than that of the particular cohort of peers;
- students have a clear and explicit understanding of the standards required for a given outcome;
- they are able to exercise greater judgement and choice in the level of outcome they target;
- students' outcomes are based on demonstrated competence rather than arbitrary and temporally inconsistent standards;
- there is greater 'transparency' in the assessment process.

Abbiss and Hay (1992) also suggest advantages for the university teacher, including encouragement in the setting of clear goals and objectives and of the planning of coherent courses most likely to achieve them, greater ease and a clearer concept of what is required when marking.

On the other hand, these authors note Power's (1986, p. 271) reservation that 'criterion-referenced systems have little place for the educational connoisseur', i.e., that there is little room for expert professional judgement. Hay (1995) then reports a re-evaluation of his earlier position (Abbiss & Hay, 1992, p. 167), describing his 'considered retreat from criterion-referenced assessment'. The reasons for Hay's reversal are as follow:

- criterion-referenced assessment is inflexible, not allowing for the circumstances of individual students;
- students are encouraged to conform to a particular communication model, potentially discouraging exploration, experimentation and styles of communication which may be very effective;
- establishment of appropriate and valid weighting systems is a task which defies even educational experts;
- despite careful specification of criteria, different markers might assess criteria in different ways, yet still agree on the final mark;
- 'losing sight of the forest while assessing individual trees' (Hay suggests that, because they know the criteria, some students may neglect the overall objectives of the assignment such that satisfaction of individual criteria becomes the main objective); and
- establishing the relationship between assessment criteria and ideas, originality, innovation and genius is virtually impossible.

In a slightly different context, albeit within higher education, Richards (1998) points out that excessive external regulation de-professionalises, lowers morale and de-skills academics. In an increasingly managed higher education environment, prescriptive implementation of criterion-referenced assessment procedures is likely to contribute to these undesirable outcomes.

Institutional Setting

In 1997, following recommendations from its Task Force on Assessment Policies and Practices (Anon., 1996), the Academic Board of the University of Queensland determined that norm referencing would no longer apply and that it would switch to totally criterion-referenced assessment from Semester 1, 1998. The trend in this and other institutions seems, to some degree, to be based on a caricature of norm-referenced assessment which misunderstands and/or ignores both norm-referencing practice and the role of professional judgement; norm referencing, as defined above, is seldom used. Nightingale *et al.* (1996, p. 9) suggest that 'few assessment strategies are entirely norm-referenced or criterion-referenced'. Similarly, Rowntree (1987) remarks that norm referencing and criterion referencing actually have more in common than is generally recognised and he demonstrates that rigid adherence to either mode defies logic. It would seem that any discussion of the relative merits of either approach should take these observations into account.

The University of Queensland's decision to alter assessment modes was taken and promulgated before adequate support and information were available. One of the consequences of the lack of a well-developed implementation strategy was the need for most individuals to 'reinvent the wheel' of criterion-referenced assessment for each subject taught. This approach seems likely to result in wasted time and resources, increased frustration and, in some cases, hostility to an approach that could have some merits. In response to this situation a generic framework for criterion-referenced assessment of written communication is presented which might be applied widely within environmental science, geography and planning departments.

The framework is organised in response to the criterion-referenced assessment requirements of the University of Queensland (available at <http://www.tedi.uq.edu.au/assess/Assessment/cra-frame.html>) which recommend:

- a set of criteria for each assessment task;
- a set of standards which might be achieved on each criterion;
- a marking scheme for each assessment task which looks at the standards reached by the student on the various task level criteria and includes ways of reporting.

Informal enquiries to a number of Australian university geography departments indicate that criterion-referenced assessment is known and used, but possibly in preliminary or imperfect ways. Interest in reliable and valid assessment has accompanied government-inspired quality-assurance initiatives which are linked to funding. Nevertheless, no document of the type presented herein has been widely discussed or circulated among departments to date.

Method

A perusal of websites and the literature revealed relatively little explicit information on criterion referencing with direct relevance to geographical education. The website of the Department of Geography at the University of Sheffield includes a listing of assessment 'criteria'. They are essentially the 'characteristics' outlined by Unwin (1990) and referred to as a 'scoring guide' by Nightingale (1996). Hay (1996) also provides an 'assessment schedule' for written assignments. Several of the case studies provided by Nightingale *et al.* (1996) also offer examples of assessment criteria relevant to geography.

The criterion-referenced assessment framework described herein follows the 'dimensions of achievement' (i.e. content, process, affect, skills) approach of Scott *et al.* (1978), which is a local adaptation of the three domains (cognitive, affective and psychomotor) that form the basis of the classic 'taxonomy of educational objectives' of Bloom *et al.* (1956) and Krathwohl *et al.* (1956). Scott *et al.* (1978) outline the

dimensions of achievement as follows:

- *content competence*: the acquisition of specified content on a particular subject;
- *process competence*: the acquisition and exercise of specified cognitive skills in a particular subject;
- *affective achievement*: the manifestation of affective responses;
- *skills competence*: the acquisition and exercise of specified practical skills.

These authors note that

... competency-based assessment should be concerned only with those learning outcomes which can be observed and measured against pre-determined criteria ...generally speaking ...only with cognitive and psychomotor learning. Affective learning objectives (attitudes and values) would be specified ...but where they cannot be measured objectively their achievement would be noted by teachers (Scott *et al.*, 1978, p. 38).

Clearly this implies limitations in application to university classes of hundreds of students, particularly if assessment is deemed valid only if undertaken according to observable and measurable pre-determined criteria.

Criteria relevant to each of the dimensions of achievement were developed and standards were formulated for each in relation to a seven-point grading scale. The University of Queensland's draft standards for English-language proficiency and communication competence (Anon., 1998) were adapted as a basis for assessing language and communications aspects of written work, and a set of standards for graphic and cartographic proficiency — in a format consistent with that for language and communication skills — was developed.

The resulting generic framework for criterion-referenced assessment in tertiary environmental science, geography and planning consists of a preamble, a set of criteria (organised by the dimensions of content, process, affect and skills), a set of standards for each criterion using a seven-point grading scale, and a set of proficiency standards for the skills required (English-language proficiency and communication competence, cartographic proficiency and graphics proficiency).

Although criterion-referenced assessment at The University of Queensland also demands a marking scheme, it has been deliberately omitted here, largely because we believe that this is the step in the process that is most likely to vary according to the specific requirements of individual assessors. Disparities between criteria in students' levels of achievement are best accounted for within the marking scheme, again with weightings and emphases determined according to the specific learning objectives and context of a given assessor. The generic framework for criterion-referenced assessment is reproduced in Appendix 1.

Implementation

Unwin's (1990) observation that 'remarkably little attention is paid in the geographical literature to the assessment of undergraduate essays' (p. 31) remains valid today. However, the higher education literature does contain increasing numbers of workable examples of assessment criteria, generally of less than one page in length (see Unwin, 1990; Nightingale, 1996). The practicality of implementing a criterion-referenced assessment scheme is probably inversely related to the length of the documentation and the number of criteria specified. On the other hand, students are unlikely to know what is expected of them if the guidelines are too brief. Those presented in Appendix 1 are intended to be comprehensive, but could be reduced as necessary. The framework should be useful for students while not presenting insurmountable difficulties for the assessor. It is recognised that a marking scheme which addresses all

the criteria and standards outlined would be largely unworkable and impractical, a further example of the inadequacies of an excessively formula-based and regimented assessment method.

The second difficulty with implementation is that, even if the assessment criteria are comprehensive, implementation still requires clear communication of the exact import of the scheme to students. For example, Nightingale (1996, p. 217) notes that 'a ... [scoring] ... guide is only generic, it does not give us the specifics about, for example, what constitutes thoughtful consideration of the issues raised by a specific question'. This residual uncertainty, even after criteria and standards are spelled out, is consistent with Hay's (1995) reservations regarding criterion-referenced assessment. Nightingale (1996) gives three examples of strategies used to tackle this problem: those of Gibbs (1981), of Hay and Delaney (1994) and of White (1994). They involve holding different forms of workshops with groups of students to develop and interpret appropriate criteria and standards. There is clearly a difficult-to-resolve, three-way trade-off among the development of subject-based knowledge and cognitive skills, improved communication skills, and unambiguous interpretation of assessment guidelines, criteria and standards.

Conclusion

Criterion-referenced assessment procedures are argued to have both advantages and disadvantages in application to tertiary teaching. Regardless of the balance of opinion on this issue, their development and application requires considerable time and effort. The generic framework for criterion-referenced assessment provided here is intended, wholly or in part, to reduce that load, and as a basis for further development of assessment criteria. Part of its value lies in its basis in recognised constructs of educational objectives (educational domains, dimensions of achievement) and explicit recognition of aspects directly relevant to environmental science, geography and planning (e.g. cartography). Considering that the scheme reproduced in Appendix 1 has only just been introduced into some, but not all, geography and planning subjects at the University of

Queensland, it is not yet possible to provide a conclusive evaluation of its reception among students and staff. Considerable interest, however, has been shown by the university's education development unit and assessment subcommittee. It is hoped to provide a further communication on its evaluation at a later date.

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NOTE

[1] 'Grading on the curve', as referred to by Nightingale *et al.* (1996), is a process in which a predetermined distribution with set intervals is applied to students' marks on an assessment item. It could apply, for example, in that a certain percentage of students would be awarded a High Distinction, Distinction etc.

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Appendix 1: Guidelines for Criterion-referenced Assessment of Undergraduate Essays

Introduction

An important part of the purpose of assessment is to encourage, direct and reinforce learning. Assessment should assist students in their learning and be capable of indicating achievement, maintaining standards and providing certification (Anon., 1996). Therefore students are likely to encounter a variety of different types of assessment aimed at encouraging various aspects of learning and evaluation of achievements. Students should make use of information, guidelines and criteria they are given (written or verbal), be aware of relevant rules and policies (e.g. with respect to late submission, plagiarism etc.) and provide academic staff with feedback on their assessment practices (e.g. through subject/teaching evaluation questionnaires).

Teaching staff should provide you with a subject outline which details the goals of the subject, the assessment requirements, the criteria which will be used for grading work submitted, and should provide you with appropriate feedback.

The following pages provide a set of generic criteria for assessment of written assignment. Additional or modified criteria may be given in the various subject profiles.

For assessment in any subject, criteria and standards specified in the subject profile will take precedence over these generic criteria.

Assessment Criteria

The following criteria should provide some guidance in what you are aiming for in your essay and report writing and in understanding the relationship between your achievement and the mark awarded. The relative importance of the various criteria can vary among subjects and among the various assessment items within subjects in response to the learning outcomes expected. For example, reference to the literature and writing style will be of less relevance in an examination than in an essay style assignment. While specific aspects of your work are important (as identified in the following criteria and standards), keep in mind that it is the total quality of the completed work that is important. You should be aiming for work that you would be proud to show to a potential employer as an example of the quality and standards of which you are capable.

In general, your written work will be assessed in relation to the following criteria:

- **Content** (which relates to the nature and scope of the materials used)
 - quality, relevance and depth of information and references.

- ◆ **Process** (which relates to your comprehension and the way in which you have made use of the materials)
 - ◆ definition of the topic and/or problem within the broader context;
 - ◆ analysis of the key issues;
 - ◆ logical sequence of argument;
 - ◆ constructive discussion and consideration of contrary arguments;
 - ◆ adequacy of supporting argument for recommendations and conclusions.

- **Affect** (which relates to the originality of your insights and your handling of value positions)
 - demonstration of original and independent thinking;
 - presentation and examination of personal views and conclusions (supported by the literature and logical argument).

- ▲ **Skills** (which relate to your proficiency in the requirements for clear presentation)
 - ▲ layout of the paper, e.g. style and appearance;
 - ▲ proficiency in language and communication;

- ▲ graphic and cartographic proficiency;
- ▲ accuracy, completeness and consistency of the way references are cited.

Assessment Standards

The standards in relation to the criteria outlined above are: *For a grade of 7 (High Distinction; > 85%)*

- use and synthesis of suggested sources, and of appropriate, high-quality material not mentioned in class or on reading lists;
- ◆ considered use of dictionary and technical terms, diagrams and/or other sources to define and set the topic in context;
- ◆ incisive and decisive specification of the key issues;
- ◆ prioritisation and exposition of the key issues in a clear and logical sequence;
- ◆ relevant contrary arguments are identified and effectively dealt with;
- ◆ discussion forms a sound basis for clear, justified and comprehensive recommendations and conclusions;
- independence of thought and obvious originality;
- demonstrated ability to weigh arguments and form clear, considered personal viewpoints;
- ▲ proficient use of textual and contextual features of English language;
- ▲ proficient use of graphics;
- ▲ proficient cartography;
- ▲ references presented at 'publishable' standard.

Overall, your work demonstrates, in an interesting or challenging way, originality based on proficiency in all the learning objectives. It also reflects consistent excellence in communications competence, graphics, cartography and referencing.

For a grade of 6 (Distinction; 75-84%)

- use and synthesis of most suggested sources, and reference to additional, good quality material;
- ◆ adequate use of dictionary and technical terms, diagrams and/or other sources to define and set the topic in context;
- ◆ clear specification of the key issues;
- ◆ key issues generally presented in a logical sequence;
- ◆ relevant contrary arguments raised but might not be fully resolved;
- ◆ discussion leads to clear and justified recommendations and conclusions;
- independence of thought and frequent originality;
- general ability to weigh arguments and form personal viewpoints;
- ▲ proficient use of textual and contextual features of English language;
- ▲ proficient use of graphics;
- ▲ proficient cartography;
- ▲ references largely error free.

Overall, your work demonstrates a comprehensive awareness and understanding of the set material. It also reflects proficiency in the technical elements, i.e. communications competence, graphics, cartography and referencing.

For a grade of 5 (Credit; 65- 74%)

- use and synthesis of major suggested sources, and reference to some additional material of mixed quality;
- ◆ use of dictionary and technical terms to define and contextualise the topic;
- ◆ overall awareness of the key issues;
- ◆ the selected key issues generally presented in a logical sequence;
- ◆ some contrary arguments raised with inadequate appreciation of their significance;
- ◆ a clear statement of conclusions and recommendations;
- some independent thought but limited originality;
- difficulties in weighing arguments and presenting personal viewpoints;
- ▲ sometimes proficient and always passable proficiency in the textual and contextual features of English language;

- ▲ sometimes proficient and always passable use of graphics;
- ▲ sometimes proficient and always passable use of cartography;
- ▲ some errors of omission or detail in presentation of references.

Overall, your work demonstrates the ability to use and apply fundamental concepts and skills, going beyond mere replication of content knowledge. It reflects passable and sometimes proficient communications competence, graphics, cartography and referencing.

For a grade of 4 (Pass; 50-64%)

- limited use and synthesis of suggested sources;
- ◆ use of dictionary or vernacular definitions in an attempt to identify and set the topic in context; some awareness of the key issues;
- ◆ some attempt to order the argument, but flaws in logical discipline;
- ◆ few contrary arguments raised and little appreciation of their significance or resolution;
- ◆ a generally clear statement of conclusions and recommendations;
- little independent thought and minimal originality;
- little weighing of argument and lack of clarity in personal viewpoints;
- ▲ passable use of textual and contextual features of English language;
- ▲ passable use of graphics;
- ▲ passable cartography;
- ▲ some errors of omission or detail in presentation of references.

Overall, your work satisfies the basic learning requirements of the assessment item. It also reflects passable proficiency in communications competence, graphics, cartography and referencing.

For a grade of 3 (Pass Conceded; 48-49%)

- , ◆, ● at the lower end of the acceptable range for most criteria for a grade of 4;
- ▲ fail standards for some textual or contextual criteria of English language competence;
- ▲ fail standards for some aspects of graphics, cartography and referencing.

For a grade of 2 (Fail; 26-47%)

- lack of awareness of sources or what the question is about;
- ◆ vernacular and confused definitions;
- ◆ general inability to identify the key issues;
- ◆ inability to order the argument;
- ◆ few, if any, contrary arguments raised and no appreciation of their significance or resolution;
- ◆ inadequate statement of conclusions or recommendations;
- no independent thought or originality;
- no ability to weigh arguments or form personal viewpoints;
- ▲ fail standard in the textual and contextual features of English language;
- ▲ fail standard of graphics, cartography and referencing.

For a grade of 1 (Serious Fail; < 26%)

- no reference to suggested sources, generally inappropriate use of materials;
- ◆ no attempt at definitions;
- ◆ no awareness of key issues, such that the paper fails to address or answer the question;
- ◆ arguments unformulated, many errors, unsupported assertions, unjustified generalisations;
- ◆ contrary arguments impugned or ignored;
- ◆ inconclusive outcome to the paper,
- no independent thought, any originality likely to be illogical;
- inability to weigh arguments, personal viewpoints absent or inadequate;
- ▲ fail standard in the textual and contextual features of English language;
- ▲ fail standard in graphics, cartography and referencing.

Communication competence has been defined as the student's ability to control the textual features of the language in a variety of contexts (Anon., 1998). Textual features in written

language include sentence and paragraph structure, semantics (including word choice), grammar, spelling and punctuation. Contextual features include the genre (or type of communication), the mode of communication (e.g. written or spoken), the audience and purpose of the communication, and appropriateness in the sequencing of information and the development and flow of ideas.

The following criteria and standards for English-language proficiency and communication competence (modified from Anon., 1998) address the textual and contextual aspects of written communication and provide a guide for what is expected across all subjects and disciplines.

Criteria

Textual features:

- (0) spelling, paragraph and sentence construction, punctuation and grammar;
- (1) word choice.

Contextual features:

- (2) purpose;
- (3) language;
- (4) information sequencing;
- (5) ideas.

Standards Proficient:

- (0) Text could contain minor errors but they are rare and can go unnoticed by the reader.
- (1) Word choice is usually vivid and cohesive.
- (2) Clearly stated purpose.
- (3) Most of the language is effective and appropriate for the audience and the mode of communication.
- (4) Information is sequenced appropriately.
- (5) Ideas are usually coherent and the work shows thoughtful progression.

Pass:

- (0) Text contains some errors, but they do not hamper communication to any significant extent.
- (1) Word choice is sometimes accurate and vivid.
- (2) Purpose is implied but not clearly stated.
- (3) Some of the language is effective and appropriate for the audience and the mode of communication.
- (4) Information is sequenced somewhat appropriately but improvement in organisation is needed.
- (5) Ideas are somewhat coherent and show some thoughtful progression.

Fail:

- (0) Text has many errors.
- (1) Word choice is poor; many errors in meaning and appropriateness to genre.
- (2) Purpose is not clear.
- (3) Inappropriate for the intended audience and the mode of communication.
- (4) Information is inappropriately sequenced, hampering communication and understanding.
- (5) Ideas are not developed coherently and do not show thoughtful progression.

The following two volumes should be consulted regarding standards of written English: Commonwealth of Australia (1994) *Style Manual for Authors, Editors and Printers*, 5th edn

(Canberra, Australian Government Publishing Service), 468 pp.

Chambers Guide to Grammar and Usage (1996) compiled by George Davidson (Edinburgh, Chambers), 528 pp.

In addition, an easy to use, pocket guide to English style is:

Strunk, W. & White, E.B. (1979) *The Elements of Style*, 3rd edn (New York, Macmillan)
(Website reference: <http://www.columbia.edu/acis/bartleby/strunk/>)

Cartographic Presentation

The presentation of spatially referenced data in the form of plans, maps, aerial photographs, and images from satellite and airborne imaging systems requires adherence to a set of well-established guidelines from the cartographic and visualisation sciences. These guidelines have been established from extensive tests of the process of graphic perception and understanding employed by different types of potential map users, from the general public to specific demographic (e.g. children) and professional (e.g. military personnel) groups. By presenting a map-product that adheres to these guidelines you are maximising the ability of the reader to understand the message or information you are trying to present and to check that it has been compiled from relevant information sources and processing/analytic techniques.

Criteria

The material presented in this section gives 12 criteria for the assessment of cartography, and a brief explanation of each one.

(1) Title and Subtitle

- Located in visually prominent position with largest/boldest text.
Indicate what is being presented and where, e.g. 'Landcover Types for the Maroochy River Watershed, 6-9-1997' .
- Should not include the words 'Map of' .
- Should not indicate the units mapped or be redundant to the legend heading.
- If the map is presented as a figure in a report or article, the title/sub-title should be included in the caption.

(2) Legend

- Located in a visually prominent area.
- Heading should include the units or features mapped, e.g. population density (persons/ km²) and should not include the words 'Legend' .
- Present as a graphically separate element by enclosing in a box within the map frame.

(3) Scale and Distance Units

- At a minimum a graphic scale bar should be included within the map area, with the scale bar being broken into consistent units, e.g. 1 km, 10 km or 100 km.
- Additional scale representations could include a representative fraction (e.g. 1:25 000).
- Group all scale representations.
- Place in an area that is visually recessive.

(4) Orientation

- Depiction of direction and its spatial variation on the map is essential.
- Indicate either by the use of a single north arrow (keep it simple) with true and magnetic bearings if required or, if using a projection where direction varies over the mapped surface, lines of latitude and longitude as low-prominence features should be used.
- A 'graticule' can also be used in this case where, instead of drawing all lines of latitude and longitude or eastings and northings, just 'tic' marks are shown on the map border.

(5) Projection and Datum

- Choice of projection to use on a map is dependent upon the size of the area you are mapping and the purpose of the map. The projection system is the mathematical transformation used to convert from the original 3-D spherical geometry of the earth's surface to the 2-D geometry of maps (digital and hard copy).
- Projection choice is especially important for regional, continental and global-scale maps.
- Choice of projection depends on the area to be mapped, the shape of the map and its purpose; the following is a list of projections suited to specific purposes:
 - equidistant (point-point distances can be measured with minimal distortion);
 - equal-area (surface areas can be measured accurately over the map area);
 - conformal (shape preserving);
 - azimuthal (direction preserving).
- Refer to texts (e.g. Robinson *et al.*, 1995 or Mulcahy & Anderson, 1997), Projections page: <http://everest.hunter.cuny.edu/mp/index.html>, or Dana (1995) Geographer's Craft-Map Projections: http://www.utexas.edu/depts/grg/gcraft/notes/gps/gps_f.html, for details on advantages and distortions of different projections.

Having selected a suitable projection, or a map, image or photo already aligned to a projection system, a text box should be placed on your map to specify the type of projection system used and the datum (horizontal and vertical) used. This enables users to make appropriate measurements and take distortions into account.

(6) Source

- Indicate where (atlas, government agency, private company, website etc.) you obtained the data used to compile your map and the time of compilation of the data.
- Information presented on a map should be broken down into base data (coastlines, drainage lines, topography and cultural features), thematic data (e.g. soil type, geology and cadastral information) or statistical data (population, socioeconomic, image data etc). If the data were from published sources, the full reference to that work and page numbers should be provided as if you were citing the information directly in the text (see referencing guidelines contained in the writing section of this guide).

(7) Place Name and Labelling

- To enable interpretation of map products and integration with the contents of your essay or article, a sufficient number of place or feature names should be included on your map.
- Place labels using appropriate cartographic conventions for point, line and area features (Robinson *et al.*, 1995).
- Level of prominence should relate to position in visual hierarchy of map.

(8) Visual Balance

- To be effective cartographic products must be visually appealing, that is they should present an ordered set of graphic and text elements, adhering to graphic standards in an uncluttered and balanced use of map space. Principles of effective use of space are detailed in Robinson *et al.* (1995).

Main principles:

- Use all available map space.
- 'Layer' the map with the most important elements being most prominent.
- Be consistent with point, line, symbol and text styles and colours.
- Avoid clutter or placing too many elements in one section of the map.

(9) Author and Compilation date

- Include a text box with your name and the date you completed the map.

(10) Borders and Neatlines

- To ensure map appears as a separate graphic entity it should be framed within a prominent border. A neatline is a thinner, less prominent line inside or outside the border, which may act as the anchor for graticule and tic marks.

(11) Hierarchical Organisation of Text and Symbols

- The presentation of graphic and text information follows guidelines to ensure that the most important information stands out and that secondary information can still be presented without cluttering the map. The figure/ground concept is central to map design, and establishes figure elements as the most important elements related to communicating the map's purpose and the ground as the background or secondary information that is still essential for the map to be interpreted. To achieve a suitable figure/ground relationship, figure elements are made to appear more visually prominent than ground elements. Relation of layers of visual prominence leads to a hierarchical structure in the map, where the most visually prominent elements are the ones which first catch your eye (e.g. title and main symbols) while the ground elements are still there, but less prominent (e.g. scale, graticule and source information).
- Any map, beyond just a location map, should have at least two basic visual levels, and utilise size, shape, colour and pattern to make those elements more or less prominent.

(12) Use of Conventions (refer to texts, e.g. Robinson *et al.*, 1995)

- When using text, symbols or colours in any cartographic product every attempt should

be made to employ existing cartographic conventions which have been tested extensively to ensure they work. The following are summary points, but you are referred to texts for details:

– Symbols:

- Qualitative: use topographic map sheet conventions.
- Quantitative: scale area of two-dimensional figures in relation to quantity being mapped.

– Isolines: lines connecting points on a surface of equal values (e.g. contours).

– Font Type, Size and Placement:

- Sans-serif fonts (e.g. arial and helvetica most suitable).
- Size should be related to level of visual prominence and standard viewing distance for map.
- Placement depends on type of feature being labelled.

– Colours:

- Conventions for depicting qualitative and quantitative differences:

- (b) Qualitative differences: colour choice should not imply that different features appear more or less bright and dark;
- (c) Quantitative difference: colour choice should be based on a progression of brightness (grey-level) or hue (colour type).

- Standard colour schemes:

Temperature Magnitude: blue (cold/low)-green-red (hot/high); Elevation (hypsometric schemes, e.g. green 5 low altitude-brown/white 5 high altitude).

Standards Proficient

All map elements presented as finely drawn linework, labelling and colour-shading with no evidence of tracing, poor drafting (sketched/untidy) or map compilation.

- (0) Title and Subtitle

Inclusion of a title which indicates the location and the variable mapped in a position and format which is visually prominent.

(1) Legend

Inclusion of a suitably labelled legend linking all map symbols to relevant explanatory information. Location of the legend in a visually prominent position which does not make the map appear cluttered or uninterpretable.

(3) Scale and Distance Units

Presentation of a graphic, verbal and representative fraction scale using the appropriate metric units. Placement of the scale in a position such that it contributes to a balanced map layout and is visually appealing.

(4) Orientation

Inclusion of a graphically simple north-point or graticule from which direction can be determined, without cluttering up the map layout.

(5) Projection and Datum

Statement identifying the projection and datum used to compile the map. Use of appropriate projection for the intended purpose of the map (e.g. equal area for a map to measure distances).

(0) Source

Correct indication provided on the source of the base cartographic data and any statistical, thematic or remotely-sensed data presented on the map. Source is indicated using an appropriate scientific referencing format for published data and details of source organisation if not published. Inclusion of relevant information or meta-data on how the data sets used were derived. Placement of source text in a visually recessive location, whilst maintaining its readability.

(1) Place Name and Labelling

Presentation of sufficient feature labels on the map from which to provide reference points for orientation or interpretation. Application of standards for label placement and a hierarchical ordering of text to highlight the most important labels/features.

(2) Visual Balance

Presentation of a map which does not appear cluttered and which utilises all available map space in a balanced and visually appealing manner. Even distribution of base map, annotation and symbols across the map frame, such that no areas appear to have too many features or are left blank.

(3) Author and Compilation Date

Statement of the name(s) of the person(s) responsible for producing the map and the date it was produced.

(4) Borders and Neatlines

Use of a complete border or neatline to identify the map as a separate graphic entity, with graticule labelling on the neatline completed using appropriate units. Application of colour and line thickness variables to highlight the importance of the border in relation to the neatline.

(5) Hierarchical Organisation of Text and Symbols

Logical application of size and colour variations of map symbols to highlight the more important features in a map, whilst avoiding a cluttered and confusing presentation. Resulting presentation appears to have a number of 'visual levels', the most prominent being related to the purpose of the map.

(6) Use of Conventions

Consistent and logical application of cartographic conventions for symbol design, label placement, font size and colour schemes to enhance the balance, hierarchical structuring and visual appeal of the map.

Pass

(1) Title and Subtitle

Inclusion in a visually prominent position of a title which indicates the variable mapped and the location.

(0) Legend

Inclusion of a suitably labelled legend linking map symbols to relevant information.

(1) Scale and Distance Units

Presentation of a graphic, verbal or representative fraction scale in appropriate metric units.

(2) Orientation Inclusion of a north-point or graticule from which direction can be determined.

(3) Projection and Datum

Statement identifying the projection and datum used to compile the map. Use of appropriate projection for the intended purpose of the map (e.g. equal area for a map used to measure distances).

(4) Source

Correct indication provided on the source of base cartographic data and any statistical, thematic or remotely-sensed data presented on the map. Source is indicated as an appropriate scientific referencing format for published data and details of source organisation if not published.

(5) Place Name and Labelling

Presentation of sufficient feature labels from which to provide points for orientation or interpretation of the map.

(6) Visual Balance

Presentation of a map which does not appear cluttered and which utilises all available map space in a balanced and visually appealing manner.

(7) Author and Compilation Date

Statement of the name(s) of the person(s) responsible for producing the map and the date it was produced.

(8) Borders and Neatlines

Use of a complete border or neatline to identify the map as a separate graphic entity, with graticule labelling on the neatline completed using appropriate units.

(9) Hierarchical Organisation of Text and Symbols

Frequent application of size and colour variations of map symbols to highlight the more important features in a map, whilst avoiding a cluttered and confusing presentation.

(10) Use of Conventions

Frequent application of cartographic conventions for symbol design, label placement, font size, colour schemes.

Fail

(1) Title and Subtitle

Lack of a title which indicates the variable mapped and location.

(0) Legend

Lack of a suitably labelled legend linking map symbols to relevant information.

(1) Scale and Distance Units

Absence of a graphic, verbal or representative fraction scale presented in appropriate metric units.

(2) Orientation Absence of a north-point or graticule from which direction can be determined.

(3) Projection and Datum

Failure to state the projection and datum used to compile map. Use of an inappropriate projection (e.g. equal area for map to measure distances).

(4) Source

No indication provided on the source of base cartographic data and any statistical, thematic or

remotely sensed data presented on the map.

(5) Place Name and Labelling

Absence of sufficient feature labels from which to provide points for orientation or interpretation of the map.

(6) Visual Balance

Presentation of a map which appears cluttered or otherwise fails to utilise all available map space in a balanced and visually appealing manner.

(7) Author and Compilation Date

Failure to include the name(s) of the person(s) responsible for producing the map and the date it was produced.

(8) Borders and Neatlines Absence of a complete border or neatline to identify the map as a separate graphic entity.

(9) Hierarchical Organisation of Text and Symbols

Limited or no application of size and colour variations of map symbols to highlight the more important features in a map, whilst avoiding a cluttered and confusing presentation.

(10) Use of Conventions

Failure to recognise and apply cartographic conventions for: symbol design, label placement, font size, colour schemes.

*Graphics and Figures
Criteria*

The material presented in this section, adapted from Hay (1996), gives 10 criteria for assessment of graphics and figures, and an explanation of each one.

- Located outside the body of the main figure.
- Should enable the figure to be independent of the text or preceding figures (i.e. able to be understood if viewed by itself).
- Indicate what is being presented, where and for what period of time, e.g. Area occupied by each land cover type in the Maroochy River Watershed, 6-9-1997 and 29-10-1988.
- Should not include the words 'Graph of' or 'Figure of' .
- Indicate the source(s) of data and statistical analysis software (if presenting results from statistical analysis or models) using an appropriate referencing system.

(2) Legend

- Locate in a visually prominent area, but it should not make the graphic appear cluttered.
- Heading should include the units or features graphed, e.g. 'Population density (persons/km²)' and should not include the word 'Legend' .
- In some cases it might be possible to explain the symbols used in the figure caption.

(3) Type of Graph

- Selection of the most appropriate type of graph to display your data succinctly and clearly (Hay, 1996:61), e.g.:

Scattergram:	Depicts direction and strength of relationship between two variables.
Line graph:	Illustrates change over time or along a profile for one or more variables.
Bar chart:	Comparative depiction of magnitude of a variable in proportion to symbol length.
Histogram:	Depicts the frequency distribution for values of a particular variable, e.g. number of students achieving set grades in a class.
Pie chart:	Area of each 'slice' of the pie is proportional to value of variable mapped, e.g. different items of expenditure in a budget.
Logarithmic graphs:	Presents data sets with wide data ranges, e.g. 0'01-10 000.

Note: All of these graphs can be produced to a professional level quite easily by using desktop statistical analysis and graphing packages (e.g. Excel, Quattro-Pro, Statistica, S-Plus etc.).

(4) Source

- Indicate where (atlas, government agency, private company, website, etc.) you obtained the data used to compile your figure/graph and the age of the data.
- If the data were from published sources, the full reference to that work and page numbers should be provided as if you were citing the information directly in the text.
- If the data are output from a statistical or numerical analysis package, a reference should be provided to the software used and to the module applied to produce the output.

(5) Labelling of Graph or Figure Elements

- To enable interpretation of graphs/figures and to facilitate effective integration with the contents of your essay or article, a sufficient number of labels should be included.
- In the case of graphs, these labels should include appropriately aligned, legible titles for each axis, and specification of the units used.
- Scales on each axis should be legible, spaced evenly, not cluttered and less visually prominent than the titles.
- All labels should be oriented such that the figure can be read from a position which does not require the page to be rotated.
- Placement of labels should also conform to the appropriate conventions for point, line and area features set out in the criteria for cartographic presentation.

(6) Visual Balance

- To be effective, graphs and figures should adhere to established standards of visual balance set out for cartographic products. They must be visually appealing, that is they should present an ordered set of graphic and text elements, adhering to graphic standards in an uncluttered and balanced use of map space.
- Main principles: Use all available graph or figure space.
 - ‘Layer’ the graphic with the most important elements being most prominent.
 - Be consistent with label, point, line, symbol and text styles and colours.
 - Avoid clutter by presenting only a limited number of variables, which can be clearly differentiated, in any graph. Fewer variables can be presented in black-and-white graphs that are limited to a number of point/line/area symbols, by comparison with graphs which include colour as a differentiating variable.

(7) Borders and Neatlines

- To ensure figure or graph appears as a separate graphic entity it should be framed within a prominent border.

(8) Hierarchical Organisation of Text and Symbols

- Refer to section of the same name in Cartographic Presentation Criteria.

(9) Use of Conventions

- Refer to section of the same name in Cartographic Presentation Criteria.

(10) Legibility and Graphic Quality

- The graph or figure should be able to be presented and understood independent of the text

of your essay.

- All graphic and textual elements should be clearly legible at normal reading distance for written essays and articles with a font size of 10 point-12 point.
- All graphics and figures should be presented using neatly and cleanly drafted lines, symbols and text work, either by hand or by use of graphical/statistical analysis software.

Standards

Proficient/Pass

All graph/figure elements presented as finely drawn linework, labelling and colour shading with no evidence of tracing or poor drafting (sketched/untidy)

(1) Caption of Title and Subtitle Inclusion of a caption which:

- indicates what is being presented, where and for what period of time, but does not include the words 'Graph of' or 'Figure of' .
- indicates the source(s) of data and statistical analysis software (if presenting results from statistical analysis or models) using an appropriate referencing system.

(0) Legend

Inclusion of a legend or key which does not make the graphic appear cluttered, but clearly explains the units or features graphed.

(1) Type of Graph

Innovative and appropriate selection of a type of graph to display your data succinctly, clearly and in a visually stimulating and appealing manner.

(2) Source

Text included in the caption to indicate where the data were obtained to compile your figure/graph and the age of the data, including full references to text, World Wide Web and software sources.

(3) Labelling of Graph of Figure Elements

Placement of a sufficient number of labels on your graph/figure to enable their direct interpretation and effective integration with material discussed in the text. All labels should be clearly legible, neatly drafted and not require rotation of the page for viewing. Hierarchical ordering of text to highlight the more prominent sections of graphs or figures.

Placement of labels should also conform to the appropriate cartographic conventions for point, line and area features set out in the criteria for cartographic presentation.

(4) Visual Balance

Presentation of an ordered set of graphic and text elements, adhering to all graphic standards in an uncluttered and balanced use of map space as follows:

- uses all available graph or figure space;
- layer the graphic, with the most important elements being most prominent;
- consistency with label, point, line, symbol and text styles and colours;
- avoiding clutter by presenting only a limited number of variables, which can be clearly differentiated, in any graph.

(5) Borders and Neatlines

The figure or graph should appear as a separate graphic entity framed within a prominent border.

(6) Hierarchical Organisation of Text and Symbols

Refer to section of the same name in cartographic presentation criteria.

(7) Use of Conventions

Refer to section of the same name in cartographic presentation criteria.

(8) Legibility and Graphic Quality

The graph or figure is able to be presented and understood independent of the text of your essay.

All graphic and textual elements should be clearly legible at normal reading distance for

written essays and articles with a font size of 10 point-12 point.

All graphics and figures should be presented using neatly and cleanly drafted lines, symbols and text, either drawn by hand or by use of graphical/statistical analysis software.

Fail

(1) Caption of Title and Subtitle

Failure to indicate what is being presented, where and for what period of time. Failure to indicate the source(s) of data and statistical analysis software (if presenting results from statistical analysis or models) using an appropriate referencing system

(0) Legend

Omission of a legend or key, or inclusion of one that makes the graphic appear cluttered, and does not clearly explain the units or features graphed.

(1) Type of Graph

Use of an inappropriate type of graph, which results in a display of your data which is messy, difficult to interpret and difficult to relate to material presented in your essay.

(2) Source

Failure to acknowledge in the caption where the data were obtained to compile your figure/graph and the age of the data, including full references to text, World Wide Web and software sources.

(3) Labelling of Graph of Figure Elements

Lack of a sufficient number of labels on your graph/figure to enable their direct interpretation and effective integration with material discussed in the body of your text. Labels not clearly legible, and require rotation of the page for viewing. No hierarchical ordering of text to highlight the more prominent sections of graphs or figures.

Placement of labels fails to conform to the appropriate cartographic conventions for point, line and area features set out in the criteria for cartographic presentation.

(4) Visual Balance

Presentation of a set graphic and text elements, which fails to adhere to all graphic standards in a cluttered and unbalanced use of map space as follows:

- failure to use all available graph or figure space;
- lack of visual layering of the graphic such that the most important elements are most prominent;
- inconsistency with label, point, line, symbol and text styles and colours;
- presenting a large number of variables that cannot be clearly differentiated.

(7) Borders and Neatlines

The figure or graph does not appear as a separate graphic entity owing to the lack of prominent border.

(0) Hierarchical Organisation of Text and Symbols

Refer to section of the same name in Cartographic Presentation criteria.

(1) Use of Conventions

Refer to section of the same name in cartographic presentation criteria.

(2) Legibility and Graphic Quality

The graph or figure cannot be understood independent of the text of your essay. All graphic and textual elements are not clearly legible at normal reading distance for written essays and articles (i.e. with a font size of 10 point-12 point). Graphics and figures not presented using neatly and cleanly drafted line, symbol and text work.

References

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