PRACTICUM
INSTITUTE OF APPLIED RESEARCH IN HEALTH SCIENCES EDUCATION

EBMA
European Board of Medical Assessors

PROJECT TITLE

Pilot Application of *Practicum Script* Clinical Reasoning Simulator to Medical Students

International collaborative project
https://universities.practicumscript.education/

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PROJECT COORDINATION

European Board of Medical Assessors (https://www.ebma.eu/)

Practicum Institute of Applied Research in Health Sciences Education. Madrid, Spain. (https://www.practicumscript.education/)

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PROSPECTIVE PARTICIPANTS

- Medical schools affiliated to EBMA & other medical schools across Europe.

  UK: Imperial College London

  UK: University of Exeter

  UK: Oxford Medical School

UK: Plymouth University

UK: Newcastle University Medical School

UK: University of Leicester

Italy: Sapienza University of Rome

Germany: Charité - Universitätsmedizin Berlin

Spain: Complutense University of Madrid

Spain: Francisco de Vitoria University

Poland: Medical University of Lodz

Portugal: University of Minho

Portugal: University of Algarve

Georgia: David Tvildiani Medical University

Belgium: Ghent University

Sweden: Uppsala University

- Non-European Medical schools invited to take part in the project.

USA: Harvard Medical School

USA: University of Alabama

Argentina: Pontifical Catholic University of Buenos Aires

Argentina: University of Salvador

Brazil: University of Sao Paulo

Chile: University of Chile

Mexico: National Autonomous University of Mexico (UNAM)

Mexico: La Salle medical school

1) Project summary

The Practicum Script (PS) program is an innovative simulation-based learning approach aimed at enhancing clinical reasoning and problem solving skills for decision-making in real patient problems. Its feedback model, in the presented problems, is based on experts´ scientific opinions and updated references from the literature (EBM).

Originally targeted toward CME/CPD, PS could also be a valuable standardized educational resource, integrated into medical schools´ curriculum, for training and assessment of the reasoning skills of the medical students.

The objective of this pilot project is to develop an applied research related to the implementation of PS for senior medical students in order to assess the feasibility of using PS at the undergraduate level of medical schools for formative longitudinal assessment purposes.

The European Board of Medical Assessors (EBMA)

EBMA is a European leading organization in the field of medical education. The development of the Practicum Script pedagogical project is aligned to the EBMA philosophy of "promoting best practices in assessment for learning in medical education In Europe, through research and it's practical application ".

The Practicum Foundation

The PRACTICUM Foundation - Institute of Applied Research in Health Sciences Education is a not-for-profit institution located in Madrid (Spain) whose mission is to promote research in pedagogy, its experimental applications and the development of didactics oriented towards teaching, learning and evaluation in the health sciences. Its main focus of research is the cognitive processes which are involved in clinical decision-making in congruence with the current concepts of the neurosciences and the cognitive psychology. Practicum is a member of the EBMA, the Association for Medical Education in Europe (AMEE) and the Association for the Study of Medical Education (ASME).

2) Background/ Rationale

"Knowing is not enough; we must apply." (Goethe)

An important concern for medical schools is that students may complete their undergraduate studies without enough skills for their clinical tasks with real patients, which can be linked to problems in performance and patient safety.
The importance of clinical reasoning for the competency of healthcare professionals and the quality of care they provide to patients has long been established.

In this scenario, there is a growing interest in pedagogical approaches that may better enhance and assess the clinical reasoning skills of students in order to promote their independent functioning in the clinical setting. In other words, medical educators are eager to assess learners in ways that go beyond their memorization of factual knowledge, toward testing their advanced knowledge application and higher-order cognitive skills in simulated clinical work.

Despite this, most medical schools still put more emphasis within their curriculum on the acquisition of a body of knowledge by the medical students than on learning strategies that facilitate the development and strengthening of clinical reasoning abilities of their students. Besides, data about standardized approaches for effective training and assessment of clinical reasoning integrated into the schools´ curriculum are lacking.

The most popular methodology that has been used for the evaluation of clinical reasoning is the script concordance test (SCT), but it only assesses a specific element of clinical reasoning: clinical data interpretation. In addition, SCT has been strongly criticized regards to the "aggregate scoring" system that it uses for summative assessment purposes.

Practicum Script as new academic proposal

The **PS** program (www.practicumscript.education) is an innovative simulation-based tool focused on self-assessment and training of clinical reasoning skills. It is based on learning-focused assessments (*self-testing*) designed to foster reasoning abilities through real challenging clinical cases in which there is a context of uncertainty and no single decision often applies. The program features a comprehensive assessment of all stages of clinical reasoning from hypothesis generation to hypothesis evaluation, a feedback model in a way that encourages *reflection-on-action* based on experts' rationales for their responses plus evidence-based medicine for each medical decision, as well as a consensus-building methodology in situations with discordant expert responses.

PS assessments are particularly suited to (1) enhance clinical reasoning *processes* rather than only *products* during decision making tasks, (2) train and reinforce the ability to integrate and apply different types of knowledge, (3) understand and weigh different perspective-taking while dealing with complex clinical cases, and (4) promote a meaningful learning through reflection.

Originally targeted toward CME/CPD and specialty training as an "assessment-for-learning" tool, PS could also be a valuable educational resource for medical students during clinical rotations that may better help them to foster their problem-solving skills and high cognitive learning skills for decision making in real-life clinical problems, which can contribute remarkably to a more effective medical practice and better patient care outcomes as end results. A major advantage of PS as a simulation system is that learners can practice skills repetitively and longitudinally with no inconvenience to patients or risk to their safety.

An interactive demonstration of the PS model can be found at
https://www.practicumscript.education/en_en/how-to-train-the-reasoning-clinic

The PS program has been audited by EBMA. The audit´s main conclusions state the following:
"The general impressions and conclusions by the team of EBMA auditors regarding the educational impact and utility of Practicum are very positive.
The team of EBMA auditors concludes that Practicum is an excellent assessment tool for learning that promotes and enhances problem-solving, clinical reasoning skills. Practicum Script is a tool compliant with the principles of EBMA, which relates to the strategic use of assessment tools to enhance and foster learning".

Furthermore, the audit report indicates that medical students from the later academic years could benefit from the use of PS. And it also suggests exploring new methods that could support the summative use of PS as well as considering the application of cognitive diagnostic model or other emerging psychometric methods to PS that could help

participants, teachers/preceptors, and institutional stakeholder to identify knowledge/reasoning gaps at an early stage.

3) Goals

The primary goals will be:

- To conduct a pilot international multicenter study, under the umbrella of EBMA, in which PS will be used as a standard clinical reasoning tool for senior medical students.
- To assess the feasibility of integrating PS as a standardized clinical reasoning training methodology in medical schools, based on:

  - The level of satisfaction and the perception of the educational benefits by medical educators and medical students with regard to the use of PS.
  - The data analysis of the participant results.

Secondary goals will be:

- To explore new psychometric methods for gathering validity and reliability evidence supporting the use of PS for medical students, as a formative tool or as a part of the longitudinal assessment strategies of the medical schools.
- To investigate the application of cognitive diagnostic model or other emerging psychometric methods to PS aimed at the creation of cognitive profiles for clinical reasoning skills and the early identification of knowledge/reasoning gaps.

4) Target: Medical students of the final academic years (during the Internal Medicine rotation).

5) Study Proposal

- **Stage 1**: Development of cases bank.
  The test material for the study will consist of a final pool of 20 clinical cases belonging to key thematic topics in internal medicine and targeted at undergraduate level. All clinical cases will present real-life situations developed to induce cognitive challenges for decision making (and not a simple memorization of factual knowledge). Multimedia resources such as images or videos will be incorporated in all the clinical cases to enhance their authenticity.

  Case development will be guided by a blueprint, containing relevant clinical problems belonging to the following topics:
  - Cardiovascular diseases – 3 cases
  - Respiratory diseases – 3 cases
  - GI disorders (including hepatology) – 2 cases
  - Neurologic diseases – 3 cases
  - Endocrine diseases (including diabetes) – 2 cases
  - Rheumatologic disorders – 2 cases

- Renal diseases – 2 cases
- Infectious diseases – 2 cases
- Hematologic diseases – 1 case

An editorial board, made up by high qualified internal medicine specialists, of the Imperial College London will take charge of the case development (case creation phase). Training for the cases construction will be done in a face-to-face 4 hour-duration workshop.

After the creation of the cases, a committee made up by 20 senior or consultant doctors (specialists in Internal Medicine) will act as a reference panel to answer and validate the cases.

Cooperation will be sought from the medical schools in order to make up an international reference panel.

Finally, the editorial group of the Imperial College London will review the reference panel answers and will perform literature searches seeking clinical evidences relevant to experts´ judgments in each clinical case (compilation phase), before the application of the cases to the medical students.

Case writers and members of reference panel should fulfill the following criteria:

- Minimum of 8 consecutive years of clinical experience as a specialist.
- Involvement in teaching roles, especially in undergraduate training programs in the previous 5 years.
- At least 50% of working time involved in patient care (currently and in the previous 5 years).

Practicum will provide an electronic platform for all processes of medical contents generation, as well as methodological guidance and support to the specialists. Members of the reference panel will be trained on the validation methodology of the cases via online seminars (1-hour duration webinars).

- **Stage 2**: Educational experience for medical students
  - It will consist in the individual response of the clinical cases by medical students using an online platform provided by Practicum (www.practicumscript.education). For each clinical case, medical students will be asked to generate hypotheses in 'free-text' format and justify them by identifying pertinent positive and/or negative findings in the case. Subsequently students will need to report, in five different clinical scenarios, how new data may affect their original hypotheses. Feedback for the participants will be based on the summaries of experts' answers and justifications, along with the clinical evidence base from the literature. Students will also be able to see the concordance between their responses and those of the experts.

- The implementation of the PS pilot to medical students will be completely free of charge for medical schools and for the participants. Personal access codes to the PS training program will be provided for all students who take part in the educational experience.

- The pedagogical experience will be originally in English language (digital platform and medical contents). Medical schools may translate the clinical cases to their own country native language at their own expense. In the event that a medical school wishes to translate the clinical cases Practicum will provide to the medical school, without any charge, an electronic platform specially designed for the purpose of translation of cases.

- Throughout the experience, students will be able to review all clinical cases they have completed through a Portfolio, which is aimed at promoting self-reflection. In addition, the educational platform allows the participants an ongoing assessment of the results that they are achieving in their training process (longitudinal self-assessment). At their discretion, medical schools could arrange to run classroom sessions to promote clinical debate between teachers and students in relation with clinical cases.

- If wanted, the program may offer the medical students the opportunity to repeat the simulation in those clinical cases in which most of their answer did not coincide with those by the panel of reference, thus, reinforcing learning.

- All data from the participants (demographic data, answers given in each clinical case, level of activity) will be collected by Practicum Institute for subsequent psychometric analysis. Personal information provided by medical students during their registration in the PS program will be treated according to the European Regulation on data protection. All data set generated from the participants in the study, automatically collected by a software program, will be treated anonymously. No individually-identifiable data about student performance will be divulged nor even shared with the medical schools.

- Satisfaction surveys will be conducted with medical students and medical educators at the end of the educational experience to explore qualitatively their perceptions about PS. The contents of the survey questionnaires will be developed by EBMA and Practicum.

- **Stage 3**: Analysis of the data generated by the pilot & development of research studies. After completion of the project, dissemination of the results will be done.

Analysis

- The level of agreement between experts' opinions shall be investigated by use of an intraclass correlation coefficient,

and/or Fleiss' kappa and/or Krippendorff's alpha if a consensus cannot be reached. These analyses, if necessary, shall use the R package *rel*.

- Two types of validity evidence based on the internal structure of the assessment tool will be applied using the participants'responses to the items:
  - For the item calibration this study shall first use hierarchical item response theory modeling which enable ordinal, polytomous responses as well as multidimensional responses in items that entail more complex decision nodes than simple multiple choice questions or very short answer questions (Meiser, T., Plieninger, H., & Henninger, M. (2019). IRT ree models with ordinal and multidimensional decision nodes for response styles and trait-based rating responses. *British Journal of Mathematical and Statistical Psychology*.). A hierarchical IRT model is illustrated on Figure 1. Fit might be assessed by *infit* and *outfit* mean square measures if a hierarchical Rasch model approach is used. If fit measures suggest the appropriateness of using more parameters, particularly the discrimination parameter, the Samejima graded response model might be used be used, generating polytomous item characteristic curves (Figure 1). The local independence assumption will be assessed by the correlations of item residuals from the Rasch model. Item residuals correlations above 0.7 shall result in withdrawal of the items with worst fit indices first. For item residual correlations between 0.3 and 0.7 the content of the items will be analyzed before a decision is taken by the researchers Item residual correlations below 0.3 shall be, in principle, accepted. The level of unidimensionality will be assessed by means of parallel analysis of the principal component analysis of the Rasch model residuals and regularization of the gaussian graphic model-based partial correlation network of the residuals obtained from of the Rasch model. Essential unidimensionality will be considered as achieved if the first residual component explains less than 5% of the total variance. Absolute unidimensionality will be considered as achieved if the regularization of the gaussian graphic model-based partial correlation network of the residuals obtained from of the Rasch model results in an empty network. Overlapping communities of items in the resulting regularized partial correlation network of items, if identified, will ensure the continuation of the psychometric analysis using a cognitive diagnostic modeling approach, described in the next paragraph. Individual reliability estimates shall be obtained using the theta score variance and the measurement error variance (i.e. squared individual

standard error of measurement estimates) for the study of reliability on single measurement moments. The analyses will use Winsteps (© 2018 John M. Linacre) and the R packages *irtrees*, *psych*, *qgraph, ggplot2*, and *cliquePercolator*.

- If the results of the hierarchical item response theory and the network analysis suggest within-item multidimensionality, the use of cognitive diagnostic modeling (CDM) will be explored and the results of the analyses to be done on the *cliquePercolation* package shall serve to create a preliminary Q-matrix in which the within-item dimensionality is specified a priori and contrasted with the Q-matrix validation procedure. Mesa plots (Figure 3) shall demonstrate the percentage of variance accountable for (PVAF) the different possible combinations of attributes for each item. Whenever a more suitable, more parsimonious vector of skills is found, the new suggested skills vector shall be displayed in the Q-matrix validation procedure. Accuracy levels, analogous to reliability coefficients shall be estimated. All CDM analyses shall use the R package *GDINA*.

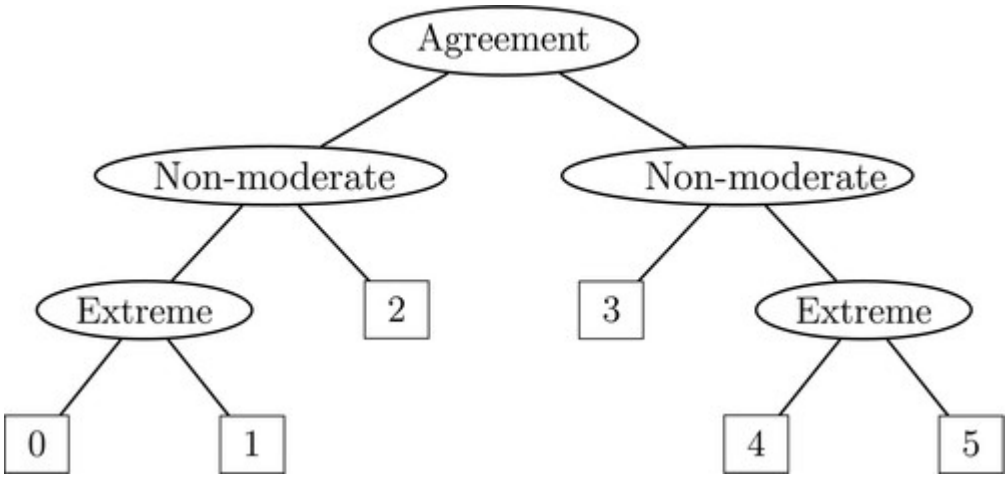

Figure 1 – Example of an IRTree (hierarchical IRT) model

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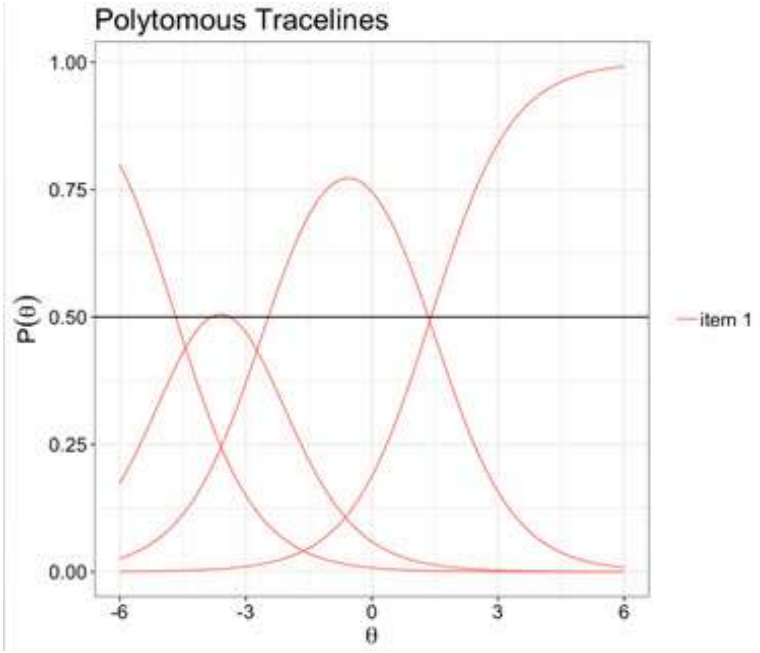


Figure 2 – Polytmous item response curve

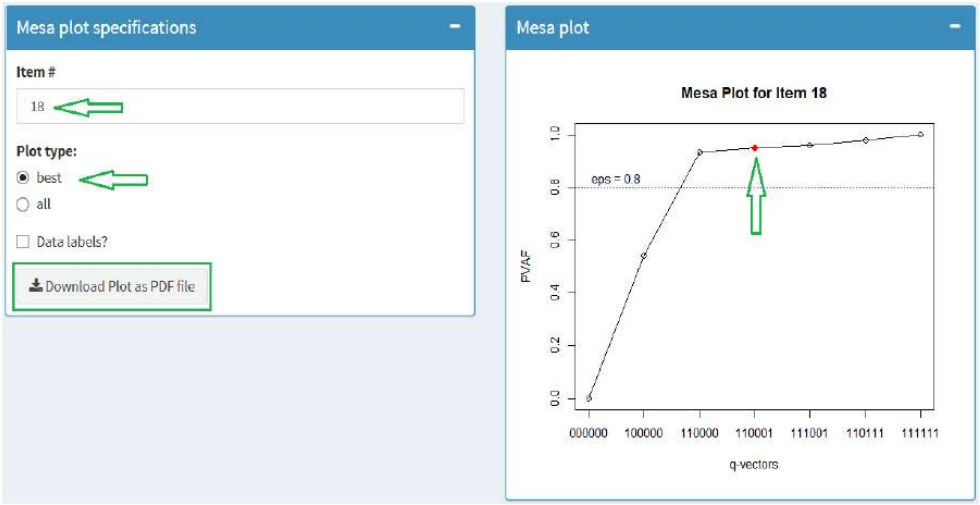
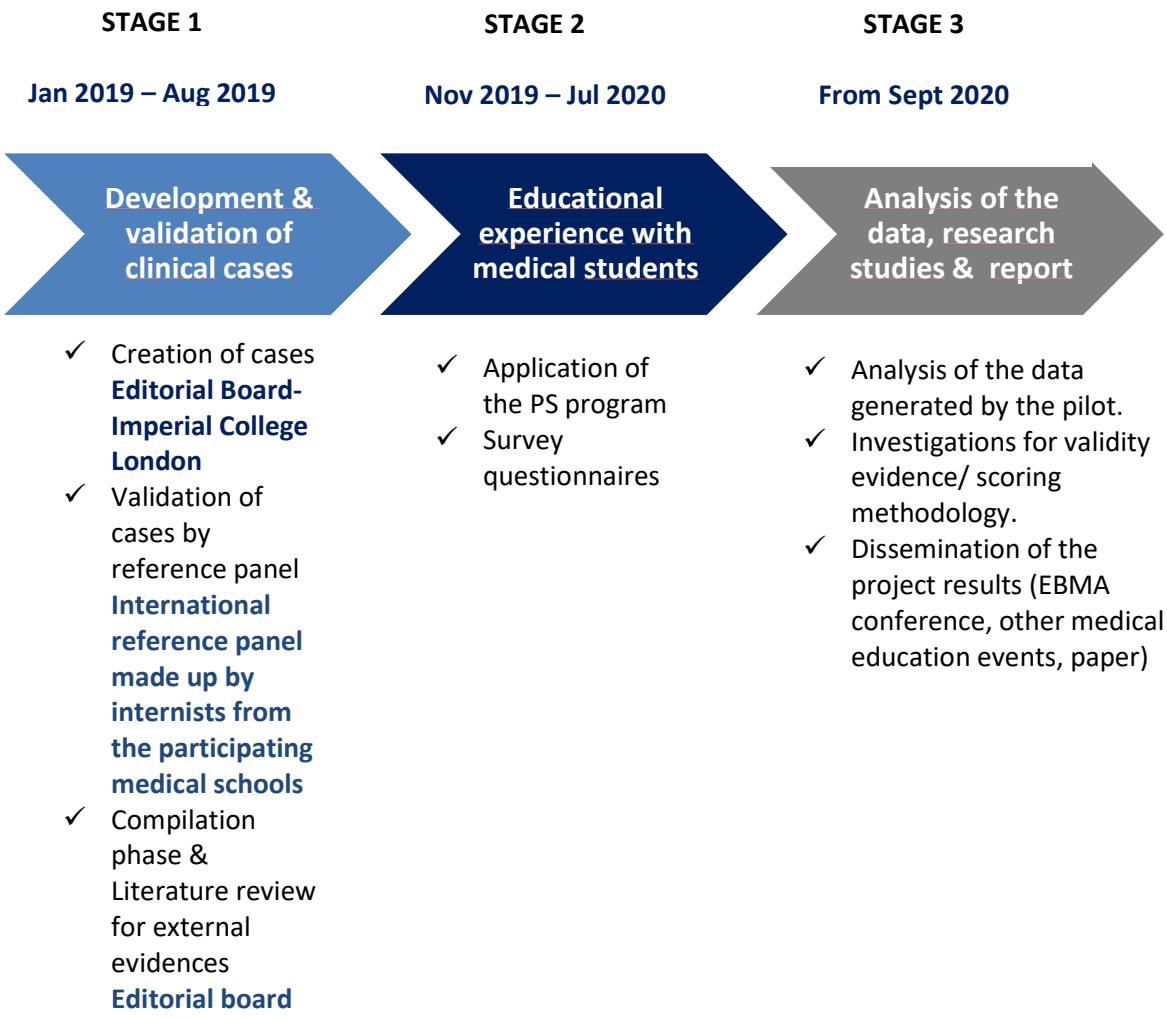


Figure 3 – Example of a mesa plot with specifications

6) Envisioned timeline



7) Perspectives

This pilot project will introduce PS for medical students.

As a result of this pilot experience and subsequent research studies:
- PS could be proposed as a standardized "assessment-for-learning" tool that could be valuable for medical students. It could likewise be expanded to other clinical rotations at the undergraduate level and to other medical schools.
- The use of PS at medical schools could combine formative and summative aspects of assessment. It could be a valuable tool to use as a formative assessment monitoring clinical reasoning skills' growth and, at the same time the results of longitudinal formative tests could be translated into a summative decision.

Expected benefits for medical students are:

- To facilitate the development and strengthening of their clinical reasoning skills in medical decision from a longitudinal exposure to real cases.
- To get used to the management of uncertainty and controversial situations in medical decision.
- To enable students to self-assess the quality of their clinical reasoning while training their reflexive abilities using authentic clinical scenarios.
- To foster a form of contextual learning in a real-life setting, which could be transferred later to the patient care.
- To help students identify their own reflective strengths and weaknesses in different content areas.
- To contribute to a better organization of medical knowledge adapted to clinical practice.

Expected benefits for medical educators are:
- To provide clerkship directors and clinical educators with valuable information concerning the clinical reasoning abilities of the students as well as their progress.
- To assist instructors to identify students who have difficulties with clinical reasoning early in their training so that remediation and timely educational intervention may be tailored accordingly (to foster improvement in clinical reasoning abilities).
- To perhaps be useful in providing objective individualized feedback to students noted to exhibit “poor judgment” during their routine clinical activities, highlighting areas of strength and weakness.
- To provide valuable feedback to instructors and clerkship directors that might help to improve the curricular development.

8) References

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