

ASSOCIATE SUPERINTENDENT APPROVAL

*[Handwritten Signature]*

STATE BOARD MEETING DATE December 2, 2013

SUBJECT: CTE Programs Eligible for Academic Credit in Mathematics

SUBMITTED BY: Dan Brown

**MANAGEMENT TEAM REVIEW:**

**BACKGROUND INFORMATION:**

The process used to crosswalk CTE Program Standards with the Arizona College and Career Ready Standards for high school was presented to the State Board for Career and Technical Education in spring 2011. At this time, the following three CTE programs have completed the four-step crosswalk identification and validation process:

- Automotive Technologies
- Business Management and Administrative Services
- Software Development

The first step in the process was to analyze the CTE programs to determine if they warranted assembling teams to do an initial crosswalk. This initial review is critical, since it is costly to assemble the appropriate teams and pay for time and travel. The second step involved assembling a small representative team of content specialist to analyze the CTE program standards and measurement criteria for embedded mathematics content and match the identified content with Arizona College and Career Ready Standards. The third step required assembling a larger team of content specialist to review and validate the initial crosswalk. Both steps two and three included mathematics specialists recommended by ADE Academic Standards Section and CTE program specialists selected by ADE-CTE. Team lists may be found in Attachment A. The crosswalk/validation process was facilitated by University of Arizona leaders who were trained in the process. The agenda for the process may be found in Attachment B. The crosswalk/validation process addresses the Arizona College and Career Ready Standards – Mathematics, specifically the Conceptual Categories and the Mathematical Practices. The validation results address the mathematics standards, the CTE Standards/Measurement Criteria, how the mathematics standard is used, and examples of the math formula used in the mathematics concept. The process and format may be found in Attachment C.

The fourth step of the process was an intense review by the ADE K-12 Mathematics Standards Team to determine if the amount of mathematics and the level of the mathematics identified in the crosswalk is sufficient for the fourth credit of mathematics in accordance with R7-2-302.02(1)(c)(iii).

**BOARD ACTION REQUESTED: [ ] INFORMATION [X] ACTION/DESCRIBED BELOW:**

It is requested that the State Board for Career and Technical Education approve the above CTE programs to be eligible for local governing boards to grant academic credit in mathematics.

ATTACHMENTS: YES [X] NO [ ]

# Validation of Math Skills in Career and Technical Education

Saturday, September 24, 2011 / 8:30 to 3:00 p.m.

ADE Central and Palm Lane Campus / 2550 N Central Avenue / Phoenix 85007

## VALIDATION TEAMS

NAME	SCHOOL	DISTRICT	CONTACT INFORMATION
<b>Automotive Technologies</b>			
Butler, Don	EVIT	EVIT	dbutler@evit.com
Damiani, David (on original analysis team)	Mountain View HS	Marana USD	d.j.damiani@maranausd.org
*Tina Grebloski (on original analysis team)	Mountain View HS	Marana USD	t.e.grebloski@maranausd.org
Henry, John	Metro Tech HS	Phoenix UHSD	jhenry@phxhs.k12.az.us
Miller, Dan	Metro Tech HS	Phoenix UHSD	dmiller@phxhs.k12.az.us
Quinn, Frank	West-Mec	West-Mec	frank.quinn@west-mec.org
Skroch, Stephen	Paradise Valley USD	Paradise Valley USD	sskroch@pvschools.net
Suprak, Russ	EVIT	EVIT	rsuprak@evit.com
Yandell, Bill	Rincon HS	TUSD	william.yandell@tusd1.org
**Lynne Bodman Storms	ASU/WEDO	ASU/WEDO	lynne.storms@asu.edu
<b>Business Management &amp; Administrative Services</b>			
Barden, Mary Ann	Alhambra HS	Phoenix UHSD	barden@phsxs.k12.az.us
*Malmin, Sadie	Kingman HS	Kingman USD	smalmin@kUSD.org
*Matakas, Tracy	Peoria USD	Peoria USD	tmatakas@peoriaud.k12.az.us
Meersman, Jean	Kingman HS	Kingman USD	tmatakas@peoriaud.k12.az.us
Palmer, Robin (on original analysis team)	McClintock HS	Tempe UHSD	rpalmer@tuhsd.k12.az.us
Shea Padilla	ADE/CTE	ADE/CTE	shea.padilla@azed.gov
**Joanne Bauman	ASU/WEDO	ASU/WEDO	joanne.bauman@gmail.com
<b>Software Development</b>			
Madden, Jim (on original analysis team)	University HS	Tucson USD	James.madden@tusd1.org
Schall, Scott	Tolleson Union HS	Tolleson UHSD	Scott.schall@tuhsd.org
*Schneider, Teresa	Tempe HS	Tempe UHSD	tschneider@tuhsd.k12.az.us
Woodward, Jeremy (on original analysis team)	Canyon Del Oro HS	Amphitheatre USD	jwoodward@amphi.com
Krickler, Chris	Guest	Guest	Guest
Tracy Rexroat	ADE/CTE	ADE/CTE	tracy.rexroat@azed.gov
**Judy Balogh	ASU/WEDO	ASU/WEDO	j.balogh@asu.edu
Maggie Mangini, ASU/WEDO, maggie.mangini@asu.edu Helen Bootsma, ADE/CTE, helen.bootsma@azed.edu			

\* Math Expert

\*\* Facilitator

# Validation of Math Skills in Career and Technical Education

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**Saturday, September 24, 2011 / 8:30 to 3:00 p.m.**

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## AGENDA

8:30 a.m. Check in and Continental Breakfast

9:00 a.m. Welcome and Introductions

*Judy Balogh, Program Manager, ASU/WEDO*

Overview

*Charlie Losh, Consultant, ASU/WEDO*

Analysis Process

*CTE Team Members*

*Dave Damiani, Automotive Technologies*

*Robin Palmer, Business Management & Administrative Services*

*Jim Madden, Software Development*

*Jeremy Woodward, Software Development*

*Math Specialists*

*Tina Grebloski*

*Sadie Malmin*

*Teri Schneider*

Validation Process

*Judy Balogh, Program Manager, ASU/WEDO*

9:30 a.m. Validation Team Work Begins

*Automotive Technologies Team, Lynne Bodman Storms, Facilitator*

*Business Management & Administrative Services Team, Joanne Bauman, Facilitator*

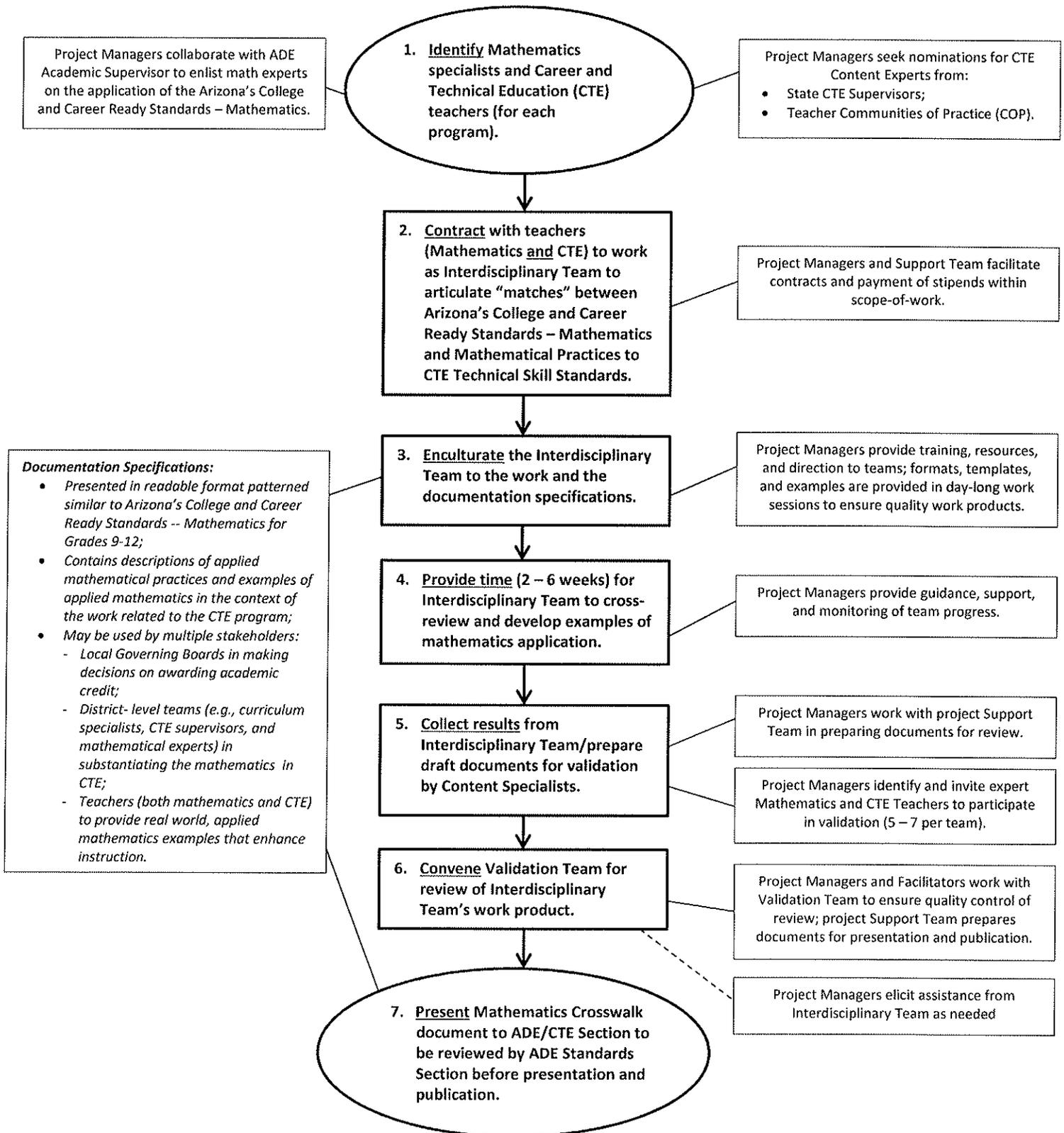
*Software Development Team, Judy Balogh, Facilitator*

12:00 pm LUNCH

1:00 p.m. Validation Team Work Continues to Work

3:00 Adjourn

# Mathematics in Career and Technical Education (CTE) Crosswalk Process



This project is collaboration between the Arizona Department of Education of Career and Technical Education Section and the University of Arizona Workforce Education Development Office (WEDO).

## High School (9<sup>th</sup> – 12<sup>th</sup>) Overview

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### UNDERSTANDING THE ARIZONA COLLEGE AND CAREER READY STANDARDS – MATHEMATICAL

The high school standards are listed in conceptual categories that portray a coherent view of high school mathematics.

#### Number and Quantity

- The Real Number System (N-RN)
- Quantities (N-Q)
- The Complex Number System (N-CN)
- Vector and Matrix Quantities (N-VM)

#### Algebra

- Seeing Structure in Expressions (A-SSE)
- Arithmetic with Polynomials and Rational Expressions (A-APR)
- Creating Equations (A-CED)
- Reasoning with Equations and Inequalities (A-REI)

#### Functions

- Interpreting Functions (F-IF)
- Building Functions (F-BF)
- Linear, Quadratic, and Exponential Models (F-LE)
- Trigonometric Functions (F-TF)

#### Modeling

##### Geometry

- Congruence (G-CO)
- Similarity, Right Triangles, and Trigonometry (G-SRT)
- Circles (G-C)
- Expressing Geometric Properties with Equations (G-GPE)
- Geometric Measurement and Dimension (G-GMD)
- Modeling with Geometry (G-MG)

##### Statistics and Probability

- Interpreting Categorical and Quantitative Data (S-ID)
- Making Inferences and Justifying Conclusions (S-IC)
- Conditional Probability and the Rules of Probability (S-CP)
- Using Probability to Make Decisions (S-MD)

##### Contemporary Mathematics

- Discrete Mathematics (CM-DM)

#### The Real Number System (N-RN)

- Extend the properties of exponents to rational exponents
- Use properties of rational and irrational numbers.

#### Quantities (N-Q)

- Reason quantitatively and use units to solve problems

#### The Complex Number System (N-CN)

- Perform arithmetic operations with complex numbers
- Represent complex numbers and their operations on the complex plane
- Use complex numbers in polynomial identities and equations

#### Vector and Matrix Quantities (N-VM)

- Represent and model with vector quantities.
- Perform operations on vectors.
- Perform operations on matrices and use matrices in applications.

#### Mathematical Practices (MP)

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

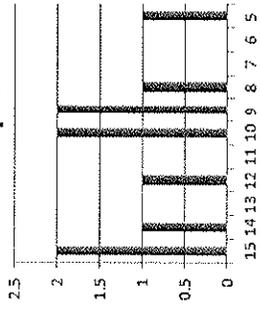
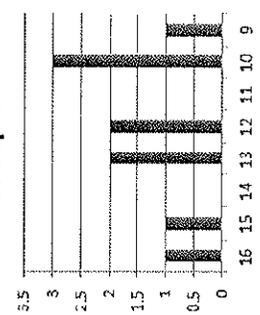
**EXAMPLE: Arizona's College and Career Ready Standards – Mathematics for AUTOMOTIVE TECHNOLOGIES**

<b>Mathematics Standards</b>	<b>TRAD</b>	<b>Mathematical Practices</b>	<b>CTE Standard/Measurement Criterion</b>	<b>Application of Mathematics Standard</b>	<b>Example of Mathematics Standard in Automotive Technologies</b>																																
HS.N-VM.7 Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.	+	HS.MP.2 Reason abstractly and quantitatively. HS.MP.4 Model with mathematics HS.MP.5 Use appropriate tools strategically.	1.1* 2.1 3.1 4.1 5.1 6.1 7.1 8.1	To evaluate vehicle and service information	<p>The following is a recall matrix for Car Company A's model line based on service information. The number of cars recalled during the second quarter was increased by 10%. What affect does this have on the number of recalls?</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <table style="border-collapse: collapse;"> <tr> <td style="padding: 5px;">A1</td> <td style="padding: 5px;">C1</td> <td style="padding: 5px;">C2</td> <td style="padding: 5px;">C3</td> </tr> <tr> <td style="padding: 5px;">A2</td> <td style="padding: 5px;">50</td> <td style="padding: 5px;">20</td> <td style="padding: 5px;">10</td> </tr> <tr> <td style="padding: 5px;">A3</td> <td style="padding: 5px;">70</td> <td style="padding: 5px;">30</td> <td style="padding: 5px;">40</td> </tr> <tr> <td></td> <td style="padding: 5px;">90</td> <td style="padding: 5px;">80</td> <td style="padding: 5px;">30</td> </tr> </table> <div style="border: 1px solid black; padding: 5px; margin-left: 20px;"> <p>A1 = model A    C1 = color 1 A2 = model B    C2 = color 2 A3 = model C    C3 = color 3</p> </div> </div> <p><b>Solution:</b></p> <div style="display: flex; justify-content: space-around; align-items: center;"> <table style="border-collapse: collapse;"> <tr> <td style="padding: 5px;">A1</td> <td style="padding: 5px;">C1</td> <td style="padding: 5px;">C2</td> <td style="padding: 5px;">C3</td> </tr> <tr> <td style="padding: 5px;">A2</td> <td style="padding: 5px;">55</td> <td style="padding: 5px;">22</td> <td style="padding: 5px;">11</td> </tr> <tr> <td style="padding: 5px;">A3</td> <td style="padding: 5px;">77</td> <td style="padding: 5px;">33</td> <td style="padding: 5px;">44</td> </tr> <tr> <td></td> <td style="padding: 5px;">99</td> <td style="padding: 5px;">88</td> <td style="padding: 5px;">33</td> </tr> </table> </div>	A1	C1	C2	C3	A2	50	20	10	A3	70	30	40		90	80	30	A1	C1	C2	C3	A2	55	22	11	A3	77	33	44		99	88	33
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HS.F-TF.5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.  Connection: ETHS-S1C2-01	A II ★	HS.MP.4. Model with mathematics.  HS.MP.5. Use appropriate tools strategically.  HS.MP.7. Look for and make use of structure.	3.57 4.5	To model harmonics to diagnose vibration concerns and what is causing the vibration	<p>An oscilloscope oscillates between 0 and 1 volt. It takes 0.2 second to complete 4 cycles. Find the period, amplitude and frequency.</p>																																

**EXAMPLE: Arizona's College and Career Ready Standards – Mathematics for BUSINESS MANAGEMENT AND ADMINISTRATIVE SERVICES**

<u>Mathematics Standards</u>	<u>TRAD</u>	<u>Mathematical Practices</u>	<u>CTE Standard/Measurement Criterion</u>	<u>Application of Mathematics Standard</u>	<u>Example of Mathematics Standard in (CTE Program name)</u>
HS.A-REI.6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.  Connection: ETHS-S6C2-03	A I A II	HS.MP.2. Reason abstractly and quantitatively.  HS.MP.4. Model with mathematics.  HS.MP.5. Use appropriate tools strategically.  HS.MP.6. Attend to precision.  HS.MP.7. Look for and make use of structure.  HS.MP.8. Look for and express regularity in repeated reasoning.	9.3   10.2	To analyze how costs affect a store's revenue potential  To utilize appropriate software (word processing, spreadsheet, database, graphics, etc.)	During the busy holiday season, a store manager hires temporary workers, some who will work part-time and others who will work full-time. <ul style="list-style-type: none"> <li>The part-time employees will work 30 hours per week at \$8.00 per hour.</li> <li>The full-time employees will work 40 hours per week at \$10.00 per hour.</li> </ul> <p>The manager hires 14 people and figures that the added staff will cost \$4,320 per week. How many part-time workers (PT) and how many full-time workers (FT) did she hire?</p> <p><b>Solution:</b></p> <p>Let <math>x</math> = part-time workers  Let <math>y</math> = full-time workers  Each part-time worker will earn \$240 per week.  Each full-time worker will earn \$400 per week.</p> $x + y = 14$ $240x + 400y = 4320$ <p>Multiply the equation by <math>-240</math></p> $-240x - 240y = -3360$ $240x + 400y = 4320$ <p>Subtract the bottom from the top.</p> $0x + 160y = 960$ <p>Divide by 160</p> $y = 6$ <p>The manager hired 6 full time workers and therefore had to hire 8 part-time workers.</p>

**EXAMPLE: Arizona's College and Career Ready Standards – Mathematics for SOFTWARE DEVELOPMENT**

<u>Mathematics Standards</u>	<u>IRAD</u>	<u>Mathematical Practices</u>	<u>CTE Standard/ Measurement Criterion</u>	<u>Application of Mathematics Standard</u>	<u>Example of Mathematics Standard in (CTE Program name)</u>															
HS.S-ID.2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.  Connections: SCHS-S1C3-06; ETHS-S6C2-03; SSHS-S1C1-01	A I ★	HS.MP.2. Reason abstractly and quantitatively.  HS.MP.3. Construct viable arguments and critique the reasoning of others.  HS.MP.4. Model with mathematics.  HS.MP.5. Use appropriate tools strategically.  HS.MP.7. Look for and make use of structure.	1.1 1.2 1.3 7.2 7.5 10.1 10.2 11.1 11.2 11.3 12.1 12.2	Students develop algorithms to compute the mean, median, and mode of data.	<p><b>Question 1</b></p> <p>Using the following data, what are the mean, median, mode, and standard deviation of those students?</p> <p>Student one scored 100. Student two scored 98. Student three scored 75. Student four scored 80. Student five scored 96.</p> <p><b>Question 2</b></p> <p>Using the following scores, what can be said about the two groups?</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th>Mean</th> <th>Median</th> <th>Range</th> <th>SD</th> </tr> </thead> <tbody> <tr> <td>Group A</td> <td>15</td> <td>15</td> <td>14</td> <td>12</td> </tr> <tr> <td>Group B</td> <td>16</td> <td>15</td> <td>13</td> <td>12</td> </tr> </tbody> </table> <div style="display: flex; justify-content: space-around; align-items: flex-end;"> <div style="text-align: center;"> <p><b>Group A</b></p>  </div> <div style="text-align: center;"> <p><b>Group B</b></p>  </div> </div>		Mean	Median	Range	SD	Group A	15	15	14	12	Group B	16	15	13	12
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